Comments

On the Draft Environmental Impact Statement for the Revision of the Resource Management Plans of the Western Oregon Bureau of Land Management Districts

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Pacific Rivers Council

I. Background and Summary

In August, 2007, the Bureau of Land Management (BLM) published a draft environmental impact statement (DEIS) regarding alternatives BLM has identified for revising the resource management plans for lands managed by the BLM in western Oregon.[1] These lands, called O&C lands, are governed by the O&C Act of 1937, which stipulates that the lands:

> *"shall be managed... for permanent forest production, and the timber thereon shall be sold, cut, and removed in conformity with the principal of sustained yield for the purpose of providing a permanent source of timber supply, protecting watersheds, regulating streamflow, and contributing to the economic stability of the local communities and industries, and providing recreational facilities."*[2]

The Pacific Rivers Council asked ECONorthwest to briefly review the extent to which the DEIS addresses a key element of this requirement, that the BLM should manage the lands "**for the purpose of ... contributing to the economic stability of the local communities and industries…**" This report responds to that request. Our findings are intended to be submitted to the BLM, which we expect it will consider as it makes decisions regarding future management of the O&C lands.

Our review shows that the DEIS contains several, overlapping flaws that distort its findings and render them unsuitable as the foundation for decisions regarding the future management of the O&C lands. The DEIS does not define "the economic stability of the local communities and industries," consistent with economic theory, it does not fully describe the current status of "the economic stability of the local communities and industries," and it does not describe what impact each of the alternatives, if implemented, would have on the "the economic stability of the local communities and industries." Instead, it embodies a simplistic presumption: that higher levels of logging and diminished protections for streams necessarily would have a positive impact on "the economic stability of local communities and industries." This presumption arises from a line of reasoning that has these four elements:

- Diminished protection for streams would enable more logging.
- With increased logging the timber industry would produce additional commodities (lumber and other wood products) and create additional employment for workers in nearby communities.
- The federal government would share revenue from the sale of logs with local counties.

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[1] U.S. Department of the Interior, Bureau of Land Management. 2007. *Draft Environmental Impact Statement for the Revision of the Resource Management Plans of the Western Oregon Bureau of Land Management Districts.* Volume I. August. Pg. 3. Retrieved November 27, 2007, from http://www.blm.gov/or/plans/wopr/deis/index.php

[2] 43 U.S.C. §1181a.

- The additional timber-industry activity, additional jobs, and shared revenue would make a positive contribution to "the economic stability of the local communities and industries."

The DEIS has failed to substantiate the validity of this line of reasoning. Instead, it has disregarded a large body of economic theory, empirical studies, and data that strongly suggest the line of reasoning is false. This body of evidence shows that the relationship between the O&C lands and "the economic stability of the local communities and industries" is complex, so that decisions regarding the future management of the O&C lands will have many different impacts, some positive and some negative. It also indicates that the positive impacts of logging on "the economic stability of the local communities and industries" probably will be smaller than they have been in the past, and the negative impacts probably will be larger, so that, on balance, there is a high likelihood that the negatives will outweigh the positives for alternatives that would lower protections for streams and increase logging on the O&C lands. Thus, although lowering protections for streams and increasing logging on the O&C lands may have some positive impact on "the economic stability of the local communities and industries," the DEIS probably has overstated this impact. It has totally failed to describe the negative impacts and the overall impacts.

There is no reasonable excuse for the BLM's failure to integrate this body of evidence into its assessment of the alternatives in the DEIS. The economic theory, empirical studies, and data are widely known and readily available. Indeed, much of this information was developed through research focused on the O&C lands and other federal forests, as well as on the communities and industries in western Oregon.

In sum, the DEIS does not—and without major revisions it cannot—provide a reasonable basis for concluding that implementing an increase in logging would satisfy the BLM's obligation to manage the O&C lands to "contribute to the economic stability in the local communities and industries." Evidence ignored by the DEIS strongly suggests that the opposite is true.

In the following paragraphs we explain our findings, separating them into three distinct, but related sections that substantiate address these conclusions:

1. The DEIS lacks an appropriate theoretical and empirical foundation and, hence, it describes the wrong things insofar as it describes the potential impacts of greater logging on "the economic stability of the local communities and industries."
2. The DEIS overstates the potential positive impacts of logging on "the economic stability of the local communities and industries."
3. The DEIS fails to describe the potential negative impacts of logging on "the economic stability of the local communities and industries."

We emphasize that this is not intended to offer an exhaustive examination of the linkages between the BLM's proposals and its obligation to "contribute to the economic stability of the local communities and industries." We present only an introduction to the relevant theoretical and empirical literature to demonstrate the BLM's failure, in the DEIS, to address these linkages.

II. THE DEIS LACKS AN APPROPRIATE THEORETICAL AND EMPIRICAL FOUNDATION

In the DEIS, the BLM contends that, since the implementation of the Northwest Forest Plan, the O&C lands have been managed to produce less timber than the lands are capable of producing on a sustainable basis and that increasing timber production, under a sustained-yield management policy, would contribute positively to the economic stability of local communities and industries:

> *"[T]he BLM has re-focused the goal for management of the BLM-administered lands to the objectives of its statutory mandate to utilize the principles of sustained yield management on the timber lands covered under the O&C Act of contributing to the economic stability of local communities and industries, and other benefits from such management to watersheds, stream flows, and recreation."*[3]

In other words, the BLM would have readers believe that more logging would mean greater economic stability for local communities and for local industries. The BLM, however, provides no theoretical foundation for this assertion and no empirical evidence to substantiate it.

The assertion, that more logging on federal lands would lead to greater economic stability for local communities and local industries, has its roots in the 1937 O&C Act, and may have reflected the economic realities of the time. For decades, however, economists and socioeconomic researchers, both inside and outside the timber industry, have demonstrated that this view is fundamentally flawed and fails to represent the forest-economy relationship accurately.

The reasoning behind the idea that managing federal forests to provide a sustained yield of timber would contribute to economic stability for local communities and industries rests on several flawed premises. It first presumes that logs from O&C lands would be utilized by local mills. It then presumes that a sustained supply of logs from O&C lands would cause the timber industry to maintain a stable level of production and jobs in these mills in nearby communities. Next, it presumes that this stability in the local timber industry would cause overall economic stability for local communities and for other industries in them. Finally, it presumes that, when logging occurs on the O&C lands, there would be no adverse impacts to offset the positive contributions of logging to the

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[3] U.S. Department of the Interior, Bureau of Land Management. 2007. *Draft Environmental Impact Statement for the Revision of the Resource Management Plans of the Western Oregon Bureau of Land Management Districts.* Volume I. August. Pg. 3 Retrieved November 27, 2007, from http://www.blm.gov/or/plans/wopr/deis/index.php

economic stability of local industries and communities. Each of these presumptions is demonstrably incorrect.

Since at least the late 1980s, researchers have shown that managing federal lands in this region to provide a sustained yield of timber does not necessarily result in economic stability for local communities and industries.[4] They also have shown that higher levels of logging on federal lands does not necessarily contribute to greater economic stability for local communities and industries, or the lower levels of logging contribute to lower levels of economic stability.[5] A careful examination of the relationships among logging on federal lands, the timber industry, and the industries and economies of local communities reveals that, even under sustained-yield management policies, the jobs and incomes it provides are vulnerable to market fluctuations, as well as technological advances and efficiency improvements that reduce the demand for labor.[6]

A recent study by researchers at the Forest Service's Pacific Northwest Research Station illustrates the extent to which the stability of communities near the federal forests in Western Oregon depends on many more factors than logging and timber-industry employment.[7] They analyzed a broader picture of stability, which they characterized as "community socioeconomic well-being," in communities in the BLM's western Oregon districts. They developed an index of socioeconomic well-being, composed of indicators derived from census data, such as diversity of employment by industry, percentage of the population with bachelor's degree or higher, percentage of workers unemployed, percentage of persons living below the poverty level, household income inequality, and the average travel time to work. Using these indicators, the researchers developed well-being scores for each community in western Oregon for 1990 and 2000. Although the BLM references these indicators in the DEIS, to our knowledge, it has not investigated how its proposals to

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[4] *See,* for example, Fortmann, L.P., J. Kusel, and S.K. Fairfax. 1987. "Community Stability: The Forester's Fig Leaf." In D.C. Le Master and J.H. Beuter, eds. *Community Stability in Forest-Based Economies: Proceedings of a Conference in Portland, Oregon, November 16-18, 1987;* Schallau, C.H. 1989. "Sustained Yield Versus Community Stability: An Unfortunate Wedding?" *Journal of Forestry* 87(9): 16-23; Schallau, C.H. 1987. "Evolution of Community Stability as a Forestry Issue: Time for the Dry Dock." In D.C. Le Master and J.H. Beuter, eds. *Community Stability in Forest-Based Economies: Proceedings of a Conference in Portland, Oregon, November 16-18, 1987*; and Routman, K. 2007. "Forest Communities and the Northwest Forest Plan: What Socioeconomic Monitoring Can Tell Us." *Science Findings.* Issue 95. August. Retrieved November 27, 2007, from http://www.fs.fed.us/pnw/sciencef/scifi95.pdf

[5] *See,* for example, Goodstein, E. 1999. *The Trade-Off Myth: Fact and Fiction about Jobs and the Environment*. Washington, D.C.: Island Press

[6] *See,* for example, Robertson, G. 2003. *A Test of the Economic Base Hypothesis in the Small Forest Communities of Southeast Alaska.* Forest Service, Pacific Northwest Research Station. December.

[7] Donoghue, E.M., N.L. Sutton, and R.W. Haynes. 2006. *Considering Communities in Forest Management Planning in Western Oregon.* United States Department of Agriculture, Forest Service. General Technical Report No. PNW-GTR-693. December.

increase logging on O&C lands would affect these indicators of community well-being.

Nor has the BLM investigated the potential relationship between the land-management alternatives in the DEIS and other indicators of community stability, such as those recently developed to assess socio-economic well being in communities associated with California's forests and rangelands.[8] This study used a wide range of indicators to assess well being, including those related to income, equity, investment in education, safe and involved communities, and environmental quality of life. It found that there is not a strong linkage between incomes generated in logging and other industries and overall socio-economic well-being. Despite dramatic reductions in logging on federal lands in the region over the past decade and a half, a majority of California's forest and rangeland counties had well-being scores that ranked higher than the state average even though they had average incomes lower than the state average.

The BLM has not described how additional logging on O&C lands would contribute to the economic stability of communities through its impacts on diversity of employment by industry, percentage of the population with bachelor's degree or higher, percentage of workers unemployed, percentage of persons living below the poverty level, household income inequality, and the average travel time to work. Nor has it described how the additional logging would contribute to economic stability through its impacts on equity, investment in education, safe and involved communities, environmental quality of life. Nor has it addressed other indicators of economic stability.

In short, the DEIS lacks a theoretical and empirical foundation that would enable the BLM (or anyone else) has to ascertain how additional logging on O&C lands would interact with today's economic realities in local communities. Instead, the DEIS rolls back the clock several decades and pretends the economies of these communities are far simpler, so that sustained logging on O&C lands would contribute positively to the economic stability of local communities and industries by stimulating additional, stable production and employment in the timber industry in these communities. In the next sections, we briefly discuss evidence indicating there is only a weak connection between additional logging on O&C lands and the timber-industry activity in local communities and that the timber industry often has a negative contribution to "the economic stability in the local communities and industries."

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[8] "Chapter 6: Socio-economic Characteristics." In *The Changing California: Forest and Range 2003 Assessment.* Retrieved November 28, 2007, from http://frap.cdf.ca.gov/assessment2003/toc.html

III. THE DEIS OVERSTATES THE POTENTIAL POSITIVE IMPACTS OF LOGGING ON THE ECONOMIC STABILITY OF THE LOCAL COMMUNITIES AND INDUSTRIES

The DEIS would have readers believe that, if the BLM were to sell more timber from the O&C lands on a sustained basis, it would lead to more logs being processed on a sustained basis by local mills, more sustained timber-related jobs for local residents, and, hence, greater economic stability for the local communities and industries. This view misrepresents the economic realities of the timber industry and the factors that determine the economic stability of communities.

A. Logging and the Economic Stability of the Local Timber Industry

Substantial evidence indicates that at least three powerful sets of economic forces—the regionalization of log markets, the price effects of increases in log supply, and globalization of wood-product markets—probably would prevent logging on O&C lands from contributing to the economic stability of the local timber industry in the manner represented in the DEIS.

Regionalization of log markets. The market for logs and other raw wood products has evolved from a large number of small, local markets to a small number of large, regional markets. Before these forces came into play, it would have been reasonable to anticipate that logs from the O&C lands would be processed by one or more mills in the nearby local communities, and an increase in logging from these lands necessarily would increase the number of logs processed in these mills. Now, however, local processing is far less likely to occur. There are far fewer mills in western Oregon, where the O&C lands are located, than in the past, and most milling capacity is concentrated in a few large mills. The mills that remain are part of a vast, regional log market. Each mill may obtain logs from lands hundreds of miles away; some have obtained logs from other states or countries.

Within this regional log market, there would be no certainty that additional logs from a parcel of O&C land would be processed by a mill in a local community. If the logs went to a distant mill, then there would be no contribution to the production of a local mill—if such a mill even exists—or to the level of timber-industry jobs for local workers.

There also might be no additional jobs for local mill workers, even if a local mill were to process the logs. The mill might, for example, keep its level of production constant and process the additional O&C logs rather than logs from somewhere else. The logs that it otherwise would have processed would, instead, be processed by another mill, which also may keep its production constant and relinquish to yet another mill the logs it otherwise would have processed. This ripple effect might continue until the net effect of the logs from the O&C lands would materialize, perhaps in a mill hundreds of miles away.

The DEIS fails to evaluate the contribution its proposals would make to the economic stability of the local communities and industries in the context of the evolving, regionalization of the log market.

Price effect. Absent evidence to the contrary, it seems reasonable to anticipate that the characteristics one usually associates with markets would apply to the regional log market that includes western Oregon. In particular, one should anticipate that increasing the supply of logs from O&C lands would, all else equal, cause the market price of logs to decline.[9] The lower price might cause some timberland owners to withhold their timber from the market. In the extreme, for every additional log from O&C lands, an equivalent log from elsewhere would be withheld from the market, and the overall, net impact would be zero. In reality, the offsetting impact probably would be less than one-to-one but, even so, the net impact on the local timber industry would be less than the increase in logs from O&C lands.

The DEIS does not quantify the price effect. Hence, it is impossible to discern from it the net effect that increased logging on O&C lands would have on the economic stability of the local timber industry.

Globalization of markets for wood products. The timber industry currently has a glut of timber. This is good news for consumers, but it is very bad news for the ability of higher log production on the O&C lands to make a positive contribution to the economic stability of the local communities and industries.

There is nothing remarkable about these conditions. The U.S. timber industry has long offered a textbook example of a commodity market that exhibits roller-coaster ups and downs. Instability in the industry is exacerbated by its evolving merger with the global industry. During the boom times as prices rise higher and higher, the ride is a blast, but it soon becomes stomach-wrenching when prices plummet and keep on falling. The consequences are not pleasant, for firm owners, workers, or adjacent communities.

The boom-bust cycle of the timber industry is not tied to the supply of timber from the O&C lands. The current dip in the price of lumber products, for example, stems from recent U.S. trade policy, an overall increase in the efficiency and capacity of U.S. and Canadian mills, and a collapse in the housing market. It is not apparent that increasing the supply of timber from the O&C lands would have a significant, if any, impact on overall behavior of the timber industry or on the behavior of individual firms in the industry. Against this backdrop, the DEIS provides no analytical basis for concluding that potential increases in timber from these lands, as proposed in the DEIS' alternatives, would have a positive contribution to the economic stability of the local communities and industries. Indeed, it seems reasonable to conclude that,

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[9] *See*, for example, Rogue River-Siskiyou National Forest. 2003. "Appendix I Socio/Economics." *DEIS for the Biscuit Fire Recovery Project.*

if the increased logging were to increase the level of activity in a community's timber industry, it might diminish the economic stability of the community and its industries.

B. Logging and the Economic Stability of Local Communities and Industries.

The DEIS presumes, but does not demonstrate, that increased logging on the O&C lands would have a positive contribution to the economic stability of local communities and industries. Moreover, it fails to address the considerable evidence indicating that higher logging is not associated with greater economic stability.

It fails, for example, to evaluate the potential economic impacts of increased logging in the context of predictions—developed little more than a decade ago on behalf of the BLM—of widespread economic collapse if timber sales on O&C lands were curtailed.[10] Those predictions derived from essentially the same reasoning embodied in the DEIS: the higher the level of logging on O&C lands, the higher the level of activity and jobs in the local timber industry and, hence, the higher the positive contribution to the economic stability of the local communities and industries. The predicted outcomes, however, failed to materialize, creating *prima facie* evidence that the reasoning is starkly incorrect.[11]

This conclusion is reinforced by more recent research, in which researchers found that, even though the amount of timber harvested annually from O&C lands had plummeted, the communities in the Eugene, Roseburg, and Salem BLM districts, where these lands are concentrated, showed statistically significant improvements in socioeconomic well-being between 1990 and 2000.[12] For western Oregon as a whole, 45 percent of communities had higher well-being scores in 2000 than they did in 1990, and another 28 percent of communities had the same score.

These results, and other evidence, clearly calls into question any claim that a potential increase in logging on O&C lands, as proposed in the DEIS, would make a positive contribution to "the economic stability of the

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[10] *See*, for example, testimony before the Endangered Species Committee by Con Schallau, Robert Lee, William McKillop, and Daniel Goldy in support of the BLM's request for exemption under the Endangered Species Act for 44 FY1991 timber sales.

[11] *See*, for example, ECONorthwest. 1996. *The Potential Economic Consequences of Designating Critical Habitat for the Marbled Murrelet: Final Report*. US Fish and Wildlife Service, Portland Field Office. May; Goodstein, E. 1999. *The Trade-Off Myth: Fact and Fiction about Jobs and the Environment*. Washington, D.C.: Island Press; and Niemi, E., E.W. Whitelaw, and A. Johnston. 1999. *The Sky Did NOT Fall: The Pacific Northwest's Response to Logging Reductions*. ECONorthwest. April.

[12] Donoghue, E.M., N.L. Sutton, and R.W. Haynes. *Considering Communities in Forest Management Planning in Western Oregon*. United States Department of Agriculture, Forest Service. General Technical Report No. PNW-GTR-693. December 2006.

local communities and industries." Until it fully evaluates the proposed increases in logging in the context of this evidence, the DEIS cannot substantiate its presumption fails to demonstrate that the alternatives in the DEIS, if adopted, would comply with the economic-stability requirement of the O&C Act.

IV. The DEIS Disregards the Potential Negative Impacts of Logging on the Economic Stability of the Local Communities and Industries

Forest ecosystems provide a variety of goods and services, other than timber commodities, that contribute to community stability and well-being, and to the stability of a wide range of industries. Moreover, a growing body of research related to amenity-driven growth and the economic importance of ecosystem services demonstrates that the economic stability of communities near federal forest lands is dependent on and influenced by much more than a sustained yield of timber, or employment in the timber industry.[13] Indeed, the growing consensus among economists is that sustaining a high-quality natural environment probably is the most important determinant of economic well-being in western communities and that industrial activities, such as logging, that can degrade the environment often impose more economic harm than good on these communities.[14]

The DEIS fails to fully examine the DEIS' alternatives in light of their impacts on goods and services other than timber. It fails to determine if the adverse impacts on these other goods and services would offset the potential positive contribution, if any, to economic stability that might materialize through increased logging. In short, the DEIS has not described what are likely to be the most important economic impacts of the DEIS' alternatives.

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[13] *See*, for example, Haynes, R.W. and A.L. Horne. 1997. "Chapter 6: Economic Assessment of the Basin." In T.M. Quigley and S.J. Arbelbide, eds., *An Assessment of Ecosystem Components in the Interior Columbia Basin and Portions of the Klamath and Great Basins, Volume IV*. Vol. General Technical Report PNW-GTR-405. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. June. 1715-1869; Rudzitis, G. 1999. "Amenities Increasingly Draw People to the Rural West." *Rural Development Perspectives* 14 (2): 9-13; and Southwick Associates. 2000. *Historical Economic Performance of Oregon and Eastern Counties Associated with Roadless and Wilderness Areas*. Oregon Natural Resources Council and World Wildlife Fund. August 15.

[14] Whitelaw, E. (editor). 2003. *A Letter from Economists to President Bush and the Governors of Eleven Western States Regarding the Economic Importance of the West's Natural Environment*. December 3.

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Niemi has taught cost-benefit analysis and economic development for the University of Oregon's Department of Planning, Public Policy, and Management. He is or has been a member of the Budget Advisory Committee for Lane Electric Cooperative, the Roads Advisory Committee for Lane County, the Board of Directors of the Pacific Rivers Council, the Board of Directors of the Center for Community and Watershed Health, the Budget Committee for the Pleasant Hill School District, the Technical Advisory Committee on Land Use and Economic Development for the Oregon Department of Land Conservation and Development, the Citizen's Task Force for Developing a Strategic Plan for the Oregon Department of Fish and Wildlife, and the Water Marketing Task Force for the Oregon Water Resources Department.

Environmental Policy and Resource Management

Restoration and Allocation of Water Resources

- Described the economic consequences of strategies proposed in the Columbia Basin Water Management Program for the Washington State Department of Ecology
- Performed an economic evaluation of watershed restoration projects in northern California to facilitate a grant application, West Coast Watershed
- Described the value of water in the Green River Basin by taking an inventory of the various categories of uses and functions of water and determining the economic value of each use and function, Wyoming Water Development Commission
- Calculated the benefits that a public water utility could realize by relying on the protection and planting of trees rather than the expansion of its waste-water treatment facility to meet water-quality objectives, private client
- Analyzed the positive and negative economic consequences of restoring natural streamflows in the Eel River, Center for Environmental Economic Development
- Analyzed and commented on a draft report regarding economic, social, and institutional issues with water allocation in the Klamath Basin, Institute for Fisheries Resources
- Described the competition for water in the Upper Klamath Basin and the relationship between water and the economy, Public Interest Projects
- Determined the share of natural and actual streamflow that originates on national-forest lands in Oregon's Willamette River Basin, U.S. Environmental Protection Agency

- Assessed the potential economic benefits and costs of the reservoir, related infrastructure, and activities included in the proposed Animas-La Plata project in southwestern Colorado, Earthjustice
- Described economic dimensions of watershed restoration to provide baseline information for designing and evaluating proposals to restore watersheds in the Sierra Nevada, Pacific Rivers Council
- Developed an integrated system for identifying areas of greater ecological and socioeconomic potential for restoration of riparian areas, U.S. Environmental Protection Agency
- Prepared a response to the Draft Environmental Impact Statement for the Columbia River System Operation Review, Confederated Tribes of the Umatilla Indian Reservation
- Described the economic effects of state water-regulation policies, Bullitt Foundation and Water Watch
- Described the economic consequences of alternative hatchery-management programs, Columbia Basin Fish and Wildlife Authority
- Reviewed the proposed economic-evaluation procedures for allocating unappropriated water in the Snake River Basin, State of Idaho Office of the Governor
- Evaluated alternative plans to manage watersheds affected by the eruption of Mount St. Helens, Cowlitz County
- Evaluated recreational fisheries in the Flathead Lake area, State of Montana
- Evaluated proposed policies for leasing wetlands, Oregon Division of State Lands

Forest Management

- Explained common errors in economic assumptions and analysis that accompany proposals for post-fire logging of federal forests
- Evaluated the feasibility of proposals to acquire forest land within a watershed and manage the forest and associated water resources to generate revenue
- Described the economic value of resources at Cooper Spur, in the Mt. Hood National Forest, that would not be developed under a proposed land swap, Crag Law Center
- Described the economic costs that might materialize if logging occurred on national forest lands that had experienced wildfire, Cascade Resources Advocacy Group
- Evaluated economic analyses that had been developed to support the implementation of a proposed habitat conservation plan for private and state-owned forest lands, private client
- Reviewed a draft chapter of a forthcoming book regarding the socioeconomic consequences of the Northwest Forest Plan, private client
- Reviewed the economic elements of the U.S. Forest Service's draft environmental impact statement of salvage logging proposals for the burned areas within the perimeter of the Biscuit Fire in southern Oregon, Siskiyou Regional Education Project
- Evaluated the need for improved voluntary measures and new regulations regarding the application of aesthetic forestry principles and techniques to state and private lands in Washington, private client

- Described the economic issues underlying proposals to conduct salvage logging in areas burned by the Biscuit Fire, Conservation Biology Institute
- Described how forest-management approaches that emphasize sustainability and stewardship can have positive economic consequences, Washington Environmental Council
- Developed a method for determining the sediment-related costs imposed on the City of Salem and its industrial/commercial water users during and following a major flood event in the North Santiam watershed, U.S. Environmental Protection Agency and National Science Foundation
- Analyzed the impacts of wildfire and fire-related programs on communities in the wildland-urban interface and on low-income residents in particular, Center for Watershed and Community Health
- Described the potential economic impacts of the Roadless Initiative in Idaho and Montana, which would prevent commercial logging on roadless areas in national forests, Wilderness Society
- Analyzed economics and collaborative decision-making to make the process of competition for natural resources more efficient and effective, Bolle Center for People and Forests
- Described the potential economic impacts of reducing logging on the national forests, the non-timber benefits the nation enjoys from these forests, and the potential benefits that would materialize if Congress opted to restore damage from past logging, Sierra Club
- Evaluated the social and economic contributions of national forests and analyzed the externalized cost of logging on national forests, Forest Guardians
- Described the economy's response in the Pacific Northwest to logging reductions, Earthlife Canada Foundation and Sierra Club of British Columbia
- Evaluated alternatives for reforestation of marginal agricultural lands in the Lower Mississippi Delta, Business Council for Sustainable Development
- Described the economic effects of forest-management strategies to enhance salmon habitat on six national forests in Idaho, Pacific Rivers Council
- Analyzed the full economic costs of salvage logging on federal lands, Pacific Rivers Council
- Described the appropriate baselines for economic impact analysis related to forest policy alternatives in the Pacific Northwest, Wilderness Society
- Developed recommendations for improving the design and implementation of policies for managing complex forest resources, U.S. Forest Service
- Assessed local economic conditions with and without a change in forest management policy that would protect remaining old-growth forests on federal lands, Wilderness Society

Endangered Fish and Wildlife

- Described the potential economic effects of federal decisions regarding the management of habitat for marbled murrelets and northern spotted owls in Washington, Oregon, and northern California, private client
- Analyzed the economic issues related to protection and restoration of habitat for the red-legged frog in California, Pacific Rivers Council

- Reviewed a draft analysis prepared by NOAA Fisheries of the potential economic consequences of designating critical habitat for 13 species of Pacific salmon and steelhead, Earthjustice
- Analyzed the U.S. Fish and Wildfire Service's draft proposal to designate critical habitat for the California gnatcatcher, Natural Resources Defense Council
- Analyzed the potential economic consequences of designating critical habitat under the federal Endangered Species Act for the cactus ferruginous pygmy-owl in Arizona, Defenders of Wildlife
- Outlined the economic issues that should be addressed in a proposal under the Endangered Species Act to designate critical habitat for bull trout in the Deschutes Basin, Deschutes Board of Control
- Evaluated alternatives for mitigating the potential adverse economic effects and for enhancing the potential positive effects of salmon recovery on the Columbia River Basin, Portland State University
- Reviewed the U.S. Army Corps of Engineers' *DRAFT Lower Snake River Juvenile Salmon Migration Feasibility Report/Environmental Impact Statement*, Trout Unlimited
- Described the economic consequences of salmon conservation along the Pacific coast of North America, Center for Watershed and Community Health
- Evaluated the economic components of the federal government's final supplemental environmental impact statement for spotted owl habitat, Sierra Club Legal Defense Fund
- Described the economic effects of designating critical habitat for the marbled murrelet in Oregon, Washington, and California, U.S. Fish and Wildlife Service
- Described the economic effects of designating critical habitat to support the recovery of two endangered species of fish in the Klamath Basin of Oregon and California, U.S. Fish and Wildlife Service
- Described the economic effects of designating critical habitat to support the recovery of an endangered species of fish in New Mexico, U.S. Fish and Wildlife Service
- Summarized existing studies on the role of fish (salmonids) in the Pacific Northwest economy, Pacific Rivers Council

Sustainable Management of Ecosystems

- Measured impacts of LNG tankers on tourism and fishing in Coos Bay
- Described the potential economic consequences of alternative uses of Nebraska's natural resources, State of Nebraska
- Described common errors in economic-impact studies that cause them to downplay the economic benefits and exaggerate the economic costs of environmental protection, Earthjustice
- Analyzed data on Oregonians' stated importance of and willingness to pay for salmon habitat recovery, U.S. Department of Agriculture, Forest Service

- Managed the drafting of a letter signed by more than 100 economists addressed to President Bush and the governors of eleven western states regarding the economic importance of the West's natural environment
- Provided technical assistance on a handbook for implementing the economic aspects of the Enlibra principles, adopted for managing natural resources, private client
- Described the economic tradeoffs of allowing, limiting, or prohibiting development in significant riparian areas and wildlife habitat in the Portland metropolitan area, Metro
- Described the economic benefits of protecting natural resources in the Sonoran Desert, Coalition for Sonoran Desert Protection
- Analyzed Louisiana's economy to help local stakeholders implement a strategy for moving the state toward conservation-based development, Ford Foundation
- Evaluated the economic consequences of different approaches to managing the environmental resources of Southern Louisiana, particularly its coastal wetlands, W. Alton Jones Foundation

Energy Resources

- Performed a cost-benefit analysis of energy efficiency and renewable energy resources, Alaska Coalition
- Evaluated the environmental externalities associated with electric utility regulation, National Association of Regulatory Utility Commissioners
- Described the impacts of proposed legislation restricting transfer of property between electric utilities, Oregon Public Utility District Association
- Assessed the environmental costs and benefits associated with emissions from one or more generic coal plants in the Pacific Northwest, Bonneville Power Administration
- Provided technical analysis and recommendations concerning incentive electric rates, special services to existing commercial and industrial customers, and recruitment, Emerald People's Utility District of Lane County, Oregon
- Calculated appropriate rates for electricity generated by small independent producers and sold to private utilities, private clients
- Reviewed policies for deregulating small-scale generation of electric power in Idaho, private client

Regional Economic Analysis

Economics of Water Resources

- Analyzed impacts to tourism and fishing due to LNG tankers coming into Coos Bay, Jordan Cove Energy Project L.P.
- Described the economic consequences of strategies proposed in the Columbia Basin Water Management Program, private client
- Detailed the financial implications and considerations of developing a regional wetlands mitigation bank in the Portland metropolitan area, Metro

- Reviewed the methodology for assessing the economic benefits from increased water delivery reliability during major system disruptions, Seattle Public Utilities
- Studied the economic benefits of protecting the water, wildlife, and other natural resources on a stretch of the Upper Mississippi River, private client
- Described the economic conditions in the Columbia River Basin, explained the reasons for the Basin's lagging economy, and highlighted potential transitions the Basin's economy may undergo, Columbia Conversations
- Reviewed the U.S. Army Corps of Engineers' *Final Environmental Impact Statement* on deepening the shipping channel in the Columbia and Willamette Rivers, private client
- Evaluated socioeconomic consequences of ecological restoration projects for the Vermillion River in South Dakota, U.S. Environmental Protection Agency
- Evaluated the economic consequences of alternative management strategies for the Virgin River, Grand Canyon Trust
- Reviewed water management and allocation policies in the Upper Rio Grande, Western Water Policy Commission
- Analyzed the role of the Columbia River in the economy of the Pacific Northwest, Northwest Water Law and Policy Project
- Analyzed the Interior Columbia River Basin Ecosystem Management Project to ensure it internalized the externalities of resource-extraction industries on federal lands in eastern Washington, eastern Oregon, and Idaho, W. Alton Jones Foundation
- Calculated the economic impacts of the Exxon Valdez oil spill on Alaskan businesses and municipalities, private client

Forest Management and the Timber Industry

- Analyzed the pending closure of a lumber mill in northeastern Washington, Wilderness Society
- Developed a methodology for analyzing the economic impacts associated with changes in forest-practices rules, Washington Department of Natural Resources
- Described the economic consequences of sustainable forest management policies in the Southern Appalachia, U.S. Forest Service
- Evaluated the relationships between forested ecosystems and regional economies, National Science Foundation
- Developed a legislative plan for dislocated timber workers, Oregon Joint Legislative Interim Committee on Forest Products Policy
- Analyzed the strengths, weaknesses, opportunities, and threats of cities responding to mill closures, Oregon Economic Development Department
- Assessed the fiscal impact of proposed alterations to timber-sales contracts for state-owned timber, Oregon Division of State Lands

Sustainable Economics

- Worked with representatives from organized labor, distressed rural communities, and urban neighborhoods to identify potential new sustainable industries and jobs, Center for Watershed and Community Health
- Developed an analytical framework for integrating resource-conservation and economic-development strategies, Ford Foundation Rural Poverty and Resources Program
- Developed recommendations for ensuring that governmental actions reinforce Oregon's strategic plan, Oregon Economic Development Department
- Evaluated economic issues associated with the Bureau of Land Management's request for a exemption from the Endangered Species Act, U.S. Fish and Wildlife Service
- Analyzed the economic impact of a plant closure and developed a strategy for a community-wide response, Dallas, Oregon, Mid-Valley Council of Governments
- Developed a comprehensive portrait of a corporation's role in Idaho's local and state economies, private client
- Prepared the socioeconomic component of draft environmental impact statements for proposed gold mines in Idaho and Montana, private clients
- Developed procedures for determining the taxable value of residential, commercial, and industrial property, Montana Department of Revenue
- Evaluated opportunities for growth in non-wood manufacturing, Lane County
- Described relationships between land-use policy and economic development, Oregon Department of Land Conservation and Development

Energy Resources

- Developed a handbook on the economic factors associated with relicensing a hydroelectric dam, Hydropower Reform Coalition
- Evaluated the feasibility of energy-conservation measures for new homes, Oregon Department of Energy
- Described the economic impact of the development of independently owned, small electricity generators, Oregon Public Utility Commission
- Described the economic impacts of the formation and expansion of public utility districts, Oregon Public Utility District Association
- Analyzed the economic, demographic, fiscal, and community-service impacts of siting a high-level nuclear waste repository at Hanford, Washington Department of Ecology
- Assessed the local economic impacts associated with the construction, operation, and decommissioning of the coal-fired electric generating facility in Boardman, Oregon, Bonneville Power Administration

Expert Testimony

- Provided testimony on the costs and benefits of water use by an energy company on the Hudson River, 2005

- Prepared a declaration challenging the U.S. Army Corps of Engineers' plan to deepen the channel of the Columbia River, 2004
- Evaluated the U.S. Army Corps of Engineers' *Final Supplemental Environmental Impact Statement* regarding the proposed Columbia River Channel Deepening Project, 2003
- Analyzed the determination of wages for firefighters in Coos Bay, 1994
- Evaluated damages stemming from the Exxon Valdez oil spill, 1994
- Evaluated claims that a manufacturer of snowmobiles violated antitrust laws, 1994
- Analyzed the determination of wages for Portland firefighters, 1985

Litigation Support

Economic Damages to Natural Resources

- Conducted a benefit-cost analysis of the State of California's ban on the use of MTBE as a gasoline oxygenate for a NAFTA arbitration matter
- Analyzed the economic damage to homeowners caused by hazardous waste pollution from mining and mineral processing activities
- Determined economic damages sustained from oil spilled from a grounded ship
- Analyzed the economic damages incurred by citizens of the State of Yap, in the Federated States of Micronesia, from a ship that grounded on the coral reef and spilled oil into the mangrove-reef ecosystem
- Reviewed economic analyses, prepared by the U.S. Department of Agriculture and the U.S. Environmental Protection Agency, of the potential economic impacts of court-ordered restrictions on the use of pesticides near salmon-bearing streams in the Pacific Northwest
- Determined the economic damages incurred by a Native American tribe after the building of a river dam
- Calculated the economic damages to the Oregon coast resulting from the abandonment of a section of the New Carissa shipwreck
- Evaluated the economic impacts to municipalities in Alaska of the oil spilled from the Exxon Valdez
- Analyzed the potential economic effects of mandatory medical monitoring for agricultural workers exposed to a toxic pesticide
- Evaluated damage claims by area businesses and property owners affected by a pesticide spill in the Sacramento River
- Calculated damages to a rose nursery from actions by a natural-gas utility

Microeconomic Analysis

- Analyzed the formation of an integrated health care delivery system in the Portland-Vancouver area
- Assisted the City of Coos Bay in its wage arbitration with municipal employees
- Analyzed the market for new frozen-potato products

- Calculated the present discounted value of alleged damages sustained by Chrysler Corporation resulting from actions of a franchisee
- Evaluated patent-infringement claims for agricultural machinery
- Evaluated the economic substance of a property sale-lease-back scheme

Antitrust Economics

- Analyzed relevant product and geographic markets for video superstores
- Evaluated potential antitrust violations by an association of licensed river pilots operating under state regulations
- Evaluated the relevant market, barriers to entry, and degree of competition in the production of maraschino cherries
- Analyzed the relevant market, impact on competition, and damages associated with alleged restrictions on the sale of replacement roller bearings for rock crushers
- Evaluated claims that a natural-gas pipeline corporation violated antitrust laws
- Evaluated claims that the suspension of a physician's hospital privileges constituted a violation of antitrust laws

Economics of Public Policy

- Analyzed the potential condemnation of privately held generating facilities by a publicly owned electric utility
- Evaluated a state's economic interest in recreational fisheries on an Indian reservation and the tribal impacts of state regulation of these fisheries
- Analyzed a public agency's proposed property condemnation, which displaced a planned private-sector development

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Analysis of Erosion and Sedimentation Issues

in the Draft Environment Impact Statement

for the Revision of the Resource Management Plans of

the Western Oregon Bureau of Land Management Districts

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ANALYSIS OF EROSION AND SEDIMENTATION ISSUES IN THE DRAFT ENVIRONMENT IMPACT STATEMENT FOR THE REVISION OF THE RESOURCE MANAGEMENT PLANS OF THE WESTERN OREGON BUREAU OF LAND MANAGEMENT DISTRICTS

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I. INTRODUCTION

Sediment is one of the key management-caused discharges affecting both water quality and aquatic habitat that will occur under each of the proposed alternatives listed in the Draft Environmental Impact Statement for Western Oregon Plan Revisions, US Bureau of Land Management, 2007 (hereinafter referred to in this report as "DEIS"). The most important sources of management-related sediment include those sources originating from harvesting and yarding activities, including mass wasting, gullying and surface erosion, as well as chronic and episodic sediment sources delivered from roads, quarries and construction sites. Other sources of sediment, such as those from recreational activities and livestock grazing, are judged regionally less important but locally significant.

The analysis presented here includes a description of various elements of the DEIS analysis that are missing and would need to be present and thoroughly presented in order to fully evaluate the effects and impacts of the proposed Resource Management Plan alternatives. In addition, many comments and critiques have been provided about specific analyses that have been included in the DEIS and in the BMPs that are supposed to provide guidance and intent to land managers during implementation of the various management actions. The following comments are typically referenced to specific DEIS sections as well as to individual pages in the DEIS where statements or conclusion have been stated.

II. SUMMARY – WATER

In summarizing the environmental consequences of the management plan on water, the DEIS states that roads near streams are primary sites where mobilization of chronic fine sediment would take place under the alternatives. In the next decade between 8 and 37 miles of permanent new roads with a natural or aggregate surface are proposed for construction within a distance that could deliver sediment to streams under all four alternatives. As mitigation, the DEIS states "most new roads would be located outside of a stream influence zone <u>where possible</u>, and therefore these miles would mostly likely not deliver fine sediment to streams channels." (DEIS, LXI).

The DEIS further states that "road improvements" and the decommissioning of roads near streams would be of greater importance to decreasing fine sediment delivery than the effect of new roads. Under all four alternatives, best management practices would be applied and are assumed to maintain or improve water quality. Best management practices generally described in the DEIS include methods that limit the delivery of sediment to streams. (DEIS, LXII)

1) The favorably stated DEIS sediment analysis rests entirely on comparing the impacts of new roads proposed for construction against the continuing impacts of the current road system. In this manner, the additional impacts seem minuscule in comparison. This is a flawed analysis that seeks to maintain the status quo, even in watersheds that have degraded water quality, reduced aquatic habitat and listed salmonid species. Use of the existing road network is a part of the actions described in the proposed RMP and each of the four alternatives depend heavily on its use and existence. The existing road network, and the impacts associated with it, cannot reasonably be excluded from the environmental analysis and from the management objectives and management actions that are proposed in the plan. Do the alternatives vary with regard to how much of the existing road network is required to execute the plan, to what standard the network is to be maintained, and how heavily it will be used? We can infer that these must vary across alternatives based on differences in logging, but neither are such differences of road network use and condition, nor their environmental effects, addressed in the DEIS.
2) Road decommissioning and "road improvement" are forwarded as mechanisms to counter-balance the increases in fine sediment discharges that will accompany the construction of new roads. The concept of "road improvement" is not defined in the DEIS and there are no management objectives, management actions, BMPs or specifications listed or described for this type of work. There is not any prior professional convention to define this term. As a proposed mechanism to offset the adverse effects of new road construction, specified "road improvements" could potentially offer a substantial opportunity for watershed restoration and protection, but this has not been done in the DEIS.
3) BMPs are "assumed to maintain or improve water quality" (DEIS, LXII) but no quantitative goals for water quality improvement or reduced sediment discharges have been forwarded for any of the four alternative resource management plans.
4) Finally, the explicitly stated uncertainty in the management actions (roads will be located outside of stream influence zones where possible) and environmental consequences (mostly likely will not deliver sediment; BMPs are assumed to improve water quality) casts serious doubt on the ability of the management actions to attain narrative target conditions (e.g., maintained or improved water quality) that have been described.

III. COMMON MANAGEMENT OBJECTIVES AND ACTIONS (ALL ALTERNATIVES)

Potential sediment impacts and management objectives aimed at sediment have been described as common for the four alternatives. Those management objectives related to water quality and sediment are generically aimed at maintaining or improving water quality through operation of the plan. The relevant management objectives include:

1) Promote ecosystem function and resiliency to wildfire (fire);
2) Reduce the risk of resource damage due to uncharacteristic wildfires; (fire)

3) Restore stream complexity; (fish)
4) Maintain and restore water quality; (water) and
5) Maintain and restore the proper functioning condition of riparian and wetland areas to provide shade, sediment filtering, and surface and stream bank stabilization. (water)

Deficiencies in management objectives and actions: Although the generic management objectives are stated with various resources and resource management actions, there is a serious deficiency in a number of the objectives and associated management actions that accompany the overall plan. These deficiencies limit the ability of the actions to achieve the anticipated results. The deficiencies are listed below.

1) Wildfire - Although the stated management objective is to reduce the risk of resource damage due to large wildfires, there are no management objectives or management actions proposed for post-fire restoration. Resource damage related to wildfire is not solely from the burning of natural resources and human infrastructure. One of the greatest environmental risks associated with the post-fire period is from increased erosion and sediment delivery originating from forest road systems, yet no management actions have been identified to address this threat (see "Other" below).

2) Generation of sediment by use of roads for log hauling - The plan alternatives are silent on the expected effects of increased commercial truck traffic on the forest road system, and on the consequent increases in fine sediment discharges, as harvests are ramped up from current levels. This will be especially true as salvage is conducted in burned areas. Increased surface runoff and organic debris transport from burned hillslopes and stream channels dramatically increases the susceptibility of stream crossings to various forms of post-fire episodic failure. Increased commercial and non-commercial traffic on forest roads generates elevated levels of fine sediment that is delivered to stream channels through hydrologically connected road reaches. Loss of vegetation on steep cut and fill slopes greatly increases the susceptibility of these slopes to mass failure and the delivery of sediment to stream channels. All these post-fire effects unnecessarily threaten downstream water quality and aquatic habitat, and they are simple and straightforward to proactively treat in the context of watershed management and post-fire restoration. In spite of this, there are no listed management objectives or management actions that have been prepared to deal with these predictable and avoidable effects of "uncharacteristic wildfires."

3) Fish and fish habitat – A generalized objective of the plan's alternatives is to increase habitat complexity, yet there are no management objectives or management actions proposed for the equally important tasks of providing increased habitat protection from upland sediment sources which can chronically or catastrophically threaten habitat quality and complexity. Fish habitat protection and restoration is not done just within the bounds of the stream channels where fish live. It comes from a watershed-wide effort to identify and treat chronic and episodic threats to fish-bearing streams and the tributary channels which supply them with quality water and food. This focused watershed-wide protection and restoration plan is missing from the three resource management action-alternatives. Roads are widely recognized as the primary source of fine sediment that impairs fish habitat in streams in the planning area (Swanson & Dyrness 1975; Beschta, 1978; Furniss et al., 1991; Wemple et al., 2001).

4) Water - Water quality restoration is an explicitly stated objective of all the plan alternatives (DEIS, 57). In summarizing the environmental consequences of the management plan on water, the DEIS states that most sediment under the alternatives is likely to originate from roads near streams. The DEIS further states that “road improvements” and the decommissioning of roads near streams would outweigh the adverse impacts of new road construction. The expected increased in sediment delivery from the forest road system under the alternatives is expected to be less than a 1% increase over current levels of sediment delivery from the existing road system. The proposed management actions (DEIS, 57) supposedly place priority for restoration, road maintenance, or road decommissioning on projects that reduce chronic sediment inputs to streams, yet nowhere is there a plan with targets and mileposts for achieving water quality objectives. In fact the term “Road Improvements” remains undefined and unexplained in the alternatives and elsewhere in the DEIS. Best management practices listed in the appendices of the plan would be implemented to meet water quality standards, but there is no proposed plan for which the BMPs can be prioritized, selected and focused to appropriate and effective locations. They are simply a list of techniques without a purposeful plan against which they can be implemented.

What is missing from the three action alternatives (Alternatives 1, 2, 3) is a rigorous plan for actually diminishing the high levels of impacts that are occurring from the existing road system. Nowhere do the alternatives address and provide for a plan with clearly stated objectives and measures proposed for water quality restoration and the reduction of water quality impacts from the existing and newly constructed road system. The DEIS states that there will be less than a 1% increase in sediment delivery as a result of implementing the proposed road construction in the WOPR. In contrast, a road restoration plan could address and specifically deal with the other 99+% of the road-related sediment impacts that are presently occurring on the BLM road system, as well as mitigating the impacts that new road construction will have. Quantitative targets (with time lines) should be set for specific actions that include reducing hydrologic connectivity of the forest road system from current levels (estimated to be 36%) to less than 15%, and stormproofing the thousands of existing stream crossings by upgrading existing undersized culverts to pass 100-year flood flows without failure or diversion of streamflow (Lew et al., 2006; Kraemer et al., 2007; Hagans et al., 2006). Stating these objectives and accomplishing the associated management actions in the context of a logical, prioritized plan-for-action are simple and concrete ways in which the plan alternatives can be made to protect and restore water quality (e.g., see Weaver and Hagans, 1996; PWA, 2000; Bundros et al., 2003; PWA, 2005). Otherwise the status quo management actions for the existing road network (which have not even been stated in the DEIS) are assumed to be sufficient to protect water quality and aquatic resources.

Without the development a specific water quality protection and treatment plan for the existing and extensive road network, the current Plan alternatives do not accomplish the DEIS management objective of maintaining and restoring water quality. In fact, without a rigorous prioritization and implementation plan, there is every reason to anticipate that the proposed measures will not be effective at attaining the benefits claimed in the DEIS. This has been institutionally recognized and addressed in the State of California’s decade-old Anadromous Fisheries Restoration Program where specific, prioritized action plans are required for all watershed-wide sediment control and road-related restoration projects. Proposed watershed restoration plans are required to follow certain state-approved road-sediment assessment and implementation methods to ensure that the sediment reduction results will be both effective and cost-effective (see Weaver et al., 2006). The mitigation measures presented in the DEIS are unlikely to mitigate sediment effectively unless they are implemented in the context of such a plan, and it is misleading to claim the supposed benefits from the practices in the apparent absence of such an assessment and plan.

5) Other – As stated in the DEIS (63), "Roads, maintenance yards, buildings, quarries, and other facilities also do not have specific management objectives or management actions but would be managed for the purpose for which the facilities were constructed." The lack of management objectives and management actions for roads and quarries and various other development sites is a serious omission of the DEIS and the plan alternatives. These activities are likely to be among the largest sources of anthropogenic erosion and sediment delivery in many of the watersheds, planning areas and districts. Failure to address these sediment sources through specific (quantitative) management objectives and associated sediment control actions is a fatal flaw in the proposed plan and the listed alternatives. Although the focus of the plan is on timber management and production, the failure of the plan alternatives to address water quality restoration and aquatic protection through the implementation of proactive management measures, especially for the existing forest road system, is a serious and unnecessary omission.

IV. MANAGEMENT OBJECTIVES AND ACTIONS – ALTERNATIVES 1, 2 ,3

The following discussion identifies elements of the plan alternatives that are missing or inadequate for accomplishing the stated sediment control and water quality objectives of the plan. Many of these plan deficiencies make the current alternative(s) untenable in their ability to perform as expected.

Alternative 1

1) RMA widths - Riparian Management Area (RMA) widths are reduced to 1 site-potential tree (fish streams) and ½ site-potential tree (non-fish intermittent streams) from the current, no action alternative. Site potential trees heights are established across BLM districts by tree height averages that will be determined at a scale no smaller than the fifth field watershed (DEIS, 69). Site potential tree height directly affects the width of the RMA within each district and the protection that the RMA provides to streams and aquatic habitat. For this reason, it is important to specifically state how that height is determined in the Plan. Because the BLM has stated that site potential tree height "would be based on district averages that are measured at a scale that is no finer than the fifth-field watershed" (DEIS, 69) it is unclear if upland non-riparian conifers are included in developing the average. If so, this will artificially lower the RMA width in riparian areas where site potential tree height would be greater than the district-wide average.

2) RMA sediment filtering and protection from mass wasting - Reduction of riparian management areas to a 1- or ½- site potential tree height reduces buffer widths and their potential sediment filtering ability by 50% (by length) over the no action alternative. This is in conflict with the stated objective of maintaining or restoring water quality that has been stated to be a common element of DEIS Alternatives 1, 2 and 3. The resulting RMA widths and associated equipment exclusion zones expressed in the alternatives are so narrow as to be generally less than that which has been shown to result in effective sediment filtering (FEMAT, 1993, V-28). The across-the-board reduction in proposed RMA widths expressed in the alternatives has also functionally reduced the capacity of the RMA to buffer the stream from harvest-related mass wasting on the steep sideslopes to streams.

3) RMA blow-down and integrity - Decreased riparian widths can also be expected to contribute to increased blow-down in the narrower RMAs that are proposed in the three RMP action alternatives, as compared to the current protections (Reid and Hilton, 1998). This will increase soil disturbance and mass wasting potential on steep inner gorge slopes. The DEIS does not mention or analyze the effects of this predictable impact of reducing the RMA width. The impact will be common to all three action alternatives and must be evaluated in the DEIS from the perspective of shade (stream temperature), sediment generation (from blow down), sediment filtering, and protection of the stream and water quality from accelerated mass wasting in the streamside zone.

4) Debris-flow prone headwalls and channels - Finally, Alternative 1 provides no specific protection to debris-flow prone ephemeral and intermittent streams and headwalls. Mass wasting failures are a significant source of management-related sediment delivery in many BLM districts and from certain bedrock geologies. Leaving out the suite of possible management objectives and management actions to avoid or minimize these sediment inputs is not consistent with the Plan's stated objective of maintaining and restoring water quality. Although some debris flow failures can add to channel complexity (provided they contain sufficient quantities of large organic debris) past and future timber harvesting in these susceptible, unprotected geomorphic locations can also result in highly damaging sediment-rich landslides and catastrophic sediment deposition in high value streams and fish habitat (Montgomery et al., 2003; Dewberry et al., 1998; Reeves et al, 1995; Hicks et al., 1991). Increased levels of harvest and reduced RMA widths and protections, compared to the current "no action" measures contained in the Northwest Forest Plan, must be assumed to result in accelerated sediment production and delivery to steams in the Plan area. For these reasons all Plan alternatives must contain provisions for the identification and protection of debris-flow-prone headwalls and channels.

Alternative 2

The RMA deficiencies identified in Alternative 1 (above) also apply to Alternative 2 and additional detail has been provided on these and other topics. In addition, a number of functional deficiencies in Alternative 2's proposed measures to protect debris-flow prone headwalls and channels are identified and described below.

1) RMA width and sediment management: Riparian Management Areas (RMA) are designed to act as a buffer adjacent perennial streams and fish-bearing intermittent streams (DEIS, 70). One function of the zone is to filter sediment and protect the adjacent stream channel from upslope sediment sources.

Variable width concept - Although not stated in the DEIS, it is assumed that the RMA width is measured on the ground surface, and thus no allowance is provided for slope steepness on stream-adjacent slopes. Sideslopes of 70% gradient are given no more protection than those of 20% gradient, yet those with steeper gradients are more likely to have slope failures and post-harvest erosion (e.g., Robison et al., 1999). Similarly, steeper channel sideslopes provide a less resistant buffer to erosion products derived and transported from upslope areas. To provide appropriate protection, the width of RMA buffers along streams should be proportional to slope steepness; i.e., steeper slopes get wider RMA filter strips.

Streamside slopes which are steep, exhibit signs of slope instability or that are located in sensitive geomorphic positions (e.g., inner gorge slopes) should also have RMAs that are expanded to fit the extent of the steep, unstable or potentially unstable slope (FEMAT, 1993). In many cases, these may extend to include the inner gorge slopes that extend well beyond the proposed RMA boundary to the first break-in-slope higher on the hillslope (FEMAT, 1993). Variable RMA widths for steep slopes and unstable slopes are common in forest practices but the DEIS provides no such protection. This is a serious oversight that will minimize the effectiveness of the RMA as a sediment buffer and filter strip.

RMA width adjacent bare soil areas - The effectiveness of the RMA as a sediment buffer depends on the source of runoff and sediment from upslope, adjacent hillslopes. Fluvial sediment that is filtered by an RMA can originate from two sources: 1) sediment from bare soil areas on the hillslope above the RMA, and 2) sediment originating from upslope forest roads. In the absence of concentrated runoff, eroded soil derived from bare areas on the hillslope usually has limited ability to move through an undisturbed filter strip. The DEIS (380) reviewed 4 studies of sediment travel distances on the forest floor and sediment was observed to be transported from 33 feet to over 300 feet, with the shortest recorded distance in Washington state of 33 feet (Rashin, 1999). Although RMA filter strip widths that prevent chronic sediment delivery within the planning area vary by physiographic province and geologic parent material (DEIS, 379), blanket RMA filter strips as low as those listed in the Table 31 (equipment exclusion of 25 feet) are not supported by the literature (DEIS, 380; Burroughs and King 1989; Rashin et al., 1999). The 25 foot undisturbed buffer (as proposed in the DEIS Alternatives 1 and 3) is not sufficient to block sediment movement into adjacent streams (DEIS, 380). Alternative 2 excludes ground-based harvesting equipment but provides only 12 conifer trees per acre retention in its 25-foot "buffer" for intermittent, non-fish-bearing streams, equivalent to a single row of trees spaced 145 feet apart, on average (DEIS, 80, 731). None of the action alternatives provide suitable filter widths to protect streams from erosion caused by logging disturbances along the upslope side of the RMA.

RMA widths adjacent upslope forest roads - Where roads are located less than about 300 feet upslope from an RMA, wider RMA filter strips will have to be employed. The DEIS model for delivery of fine sediment from roads uses 200 feet as the average delivery distance for sediment eroded from road surfaces and delivered to downslope areas by normal cross drains. The DEIS has adopted this "buffer" model as the generalized limit of sediment flux and delivery from roads. Research of eroded material travel distances below fill slopes shows that more than 95% of the relief culverts can be prevented from contributing sediment to streams if the travel distance is 300 feet or more. Roads with broad-based dips have nearly 100% of the contributing eroded material stopped within a travel distance of 100 feet (Burroughs and King 1989). Typically, 100 feet or more is used as the model delivery distance for runoff from non-concentrated sources from roads, and 300 feet is used as the delivery distance for concentrated runoff from culverts. Studies have shown a buffer distance of about one site-potential tree height (100+ feet) would effectively remove sediment in most situations (FEMAT 1993).

The DEIS states that road segments that are not connected to streams by gullies can be filtered by 25 to100 feet of forest floor duff and vegetation (depending on the slope, soil properties, and surface roughness) (DEIS, 373). Where drainage waters from an erosion source are concentrated, such as from an upslope ditch relief culvert on a forest road, the buffer widths necessary to trap eroded sediment in an RMA filter strip is significantly greater, up to 300 feet or more (USDI/USDA, 1994). For these reasons, a conservative and realistic RMA width of no less than 100 feet of undisturbed slope should be employed to provide a filtering buffer against sediment eroded and transported from upslope areas, whether it originates from diffuse sources along roads or from disturbed sites on adjacent logged hillslopes. The minimal undisturbed RMA widths in the DEIS (Table 31) are not suitable for protecting streams from sediment derived from either bare soil areas or from roads located within several hundred feet upslope of the RMA.

2) Debris-Flow Prone Intermittent Streams – Some protection is proposed in Alternative 2 for debris-prone intermittent streams, defined as: “Intermittent streams that are below unstable headwalls (as identified by the timber production capability classification (TPCC) codes indicating significant instability (i.e., FGNW, FPNW, and FGR2)) that would periodically deliver large wood to fish-bearing streams. Intermittent streams that would not deliver large wood to fish-bearing streams because of geomorphic conditions (such as stream junction angle and low stream gradient) or roads would not be included” (DEIS, 80). Although this is in contrast to the conspicuous lack of such protection that was proposed for Alternative 1, the limited extent of the protected areas and management measures included in Alternative 2 are still grossly insufficient and unsupported by the literature.

First, the identification of unstable headwalls should not be limited to existing map classification units, as proposed in DEIS Table 31. Unstable headwalls and channels should also include those unstable features that have been or will be identified in the field setting but may not currently be depicted on BLM maps. Field identification is a critical final step in determining site-specific landslide susceptibility, especially for small-scale headwalls and steep zero-order basins.

Secondly, the proposed protection measures described in Table 31 are only aimed at taking advantage of the beneficial effects of debris flow recruitment and transport of large wood to fish-bearing streams, not at actually reducing the occurrence of management-related debris flows. Not all management-related debris flows are beneficial; in fact many are not. The DEIS analysis does not specifically consider or discuss the adverse impacts that occur when debris flow failures of harvested headwalls and steep ephemeral streams deliver large quantities of wood-poor sediment to these same streams. This is a common occurrence on harvested hillslopes, and by not protecting these sensitive landscape locations through the use of expanded RMAs and no-harvest zones the management actions proposed in Alternative 2 will further increase the occurrence of damaging sediment-rich, wood-poor debris flows in the plan area.

Since many debris flows originate in steep headwall and ephemeral stream channels, and then travel down intermittent and small perennial streams, all these sites should be provided protection from disturbance and harvesting. The DEIS analysis states that basal area retention of forest trees can be important in preventing landslides on unstable terrain (DEIS, 379). For this reason, the source areas and transport corridors for debris flows all need to be excluded from harvesting and ground-based yarding. In this manner, the frequency and content of debris flows occurring in these locations will be more characteristic of the unmanaged condition. The protection that is proposed in the DEIS is far too limited to effectively guard against the adverse effects of harvest-related debris flow origination. The protection from equipment disturbance and timber harvest proposed in Alternative 2 needs to be expanded to include all debris flow prone headwalls, swales and stream channels, not just "intermittent streams that are below unstable headwalls."

3) Lakes, Natural Ponds, and Wetlands - The buffer for sediment movement from harvest areas adjacent lakes, ponds and wetlands is far too narrow to be functionally effective. As proposed in the DEIS (Table 31) ground-based yarding equipment (e.g., bulldozers) are only excluded from operating and constructing skid trails within 25 feet of features that are larger than ¼ acre in size. Depending on the sideslope steepness, a 25 foot buffer is grossly insufficient for providing a filter against sediment movement from the adjacent harvest area to the water body. For water features that are less than ¼ acre, no equipment limitations have been proposed in Alternative 2 and bulldozers can build skid trails, push dirt and yard logs right up to the edge of the lake, pond or wetland. There is no sediment filter or buffer proposed in the DEIS. It is further inconceivable that constructed ponds, ditches and canals would receive a 25-foot no-harvest and equipment exclusion zone (Table 31) while small natural lakes, ponds and wetlands would not. The buffer protections provided by the proposed "Zone-Specific Management Actions" (DEIS Table 31) to adjacent lakes, natural ponds and wetlands are completely insufficient to protect aquatic, riparian and wetland resources. The buffer width should be increased in a manner that is consistent with its ability to act as a sediment filter for erosional products produced on adjacent harvested and yarded hillslopes. As with the RMA for streams, steeper hillslopes will require wider undisturbed filter strips if they are to be effective in protecting adjacent streams and water bodies from sedimentation derived from ground disturbing activities outside (or inside) the RMA.

4) Intermittent Non-Fish-Bearing Streams - Small streams are the conveyor belts that feed sediment downstream to larger fish-bearing streams and rivers with multiple beneficial uses. A watershed's stream network is integrated and highly connected and what happens high in the stream system eventually works its way downstream to larger and more biologically productive and diverse watercourses (Bilby et al. 1989; Lancaster et al., 2001). Non-fish-bearing streams play a vital role in delivering clean, cool water and food materials to fish-bearing streams lower in the watershed. For this reason, they require protection from the adverse effects of management and soil disturbance.

The DEIS proposes only limited protection for non-fish-bearing intermittent streams. For Alternative 2, a 25 foot equipment exclusion zone (EEZ) is proposed and a limited number of conifers of non-specified size would be retained on an average 145 foot spacing (12/acre) (DEIS Table 31, Figure 255). Harvesting is allowed with no specific shade protection requirements. All large conifers can be removed as long as 12 small conifers per acre are left behind. As with the previous proposals the RMA width is rigidly set at 25 feet without regard to sideslope steepness or instability. A 25 foot filter strip is completely insufficient protection against sediment movement from the adjacent harvested and yarded hillslopes, and sediment fed into the non-fish-bearing stream channels will be carried directly downstream to areas of fish habitat and high value waters with multiple beneficial uses. The RMA for non-fish-bearing intermittent streams needs to be of variable width, depending on slope steepness and slope instability, and it should not be less than 100 feet.

5) Ephemeral Streams – According to the USGS, streams are classified based on flow frequency as perennial, intermittent or ephemeral. Perennial streams are deeper than the groundwater table year round so they are flowing continuously; intermittent streams are below the groundwater

table for some of the year and above it during other times of the year; and in ephemeral streams, the bottom of the channel never intersects with the groundwater table and so they typically carry flow only in direct response to large rainfall events (US Army Corps of Engineers, 2007). Ephemeral streams do not typically have a water influence zone with unique vegetation and soils found adjacent to perennial and intermittent streams. Therefore, ephemeral streams are typically protected with standards other than RMA prescriptions. These include such measures as equipment exclusion zones for steep erosion-prone slopes and soils or no harvest zones in debris-flow-prone channels.

The BLM defines only two types of streams in the DEIS that will receive protection: perennial streams and intermittent streams. The DEIS is silent on any protection measures that are planned for ephemeral streams within the Plan area. Although FEMAT explicitly and intentionally grouped intermittent and ephemeral streams into a single protection category, the BLM is silent about this. Because of this omission, it is assumed that the DEIS (all alternatives) proposes to provide no protection for any ephemeral streams on the landscape, even though “BLM lands are more heavily concentrated in headwaters, typified by small, typically steep gradient high-energy streams”(DEIS, 364). Almost all ephemeral streams in mountainous areas have a streambed and bank and are capable of erosion and sediment transport. Ephemeral streams transport sediment that is supplied to them from natural or management-caused disturbances and are an integral and important part of the stream channel network. They feed sediment and water to larger channels downstream and eventually to fish-bearing streams and high-value waterbodies (DEIS, 364). For example, roads crossing ephemeral streams have been identified as a major source of sediment to steepland stream systems (Bilby et al. 1989). Bilby found that the delivery of road sediment to larger streams often depends on its transport through smaller channels. This is not recognized or accommodated in the DEIS. That is, proposed RMA management actions in the DEIS (Table 31) provide no specific protections to ephemeral streams and stream channels or to their immediate banks or sideslopes. Most sediment originating from disturbed surfaces outside the riparian area was transported through the RMA in small intermittent and ephemeral stream channels (Rashin et al., 1999).

Land use disturbances create the opportunity for sediment to enter the perennial stream system directly, or through connection with intermittent and ephemeral streams, and create increased levels of fines that fill pools and decrease spawning habitat quality. Sediment is produced from erosion caused by unstable stream banks, roads, logging impacts, yarding disturbances and from loss of large wood. “Loss of wood [or lack of wood] in intermittent and ephemeral channels results in sediment being quickly transported downstream to perennial reaches.” These perennial streams include fish-bearing stream channels. “Large wood in ephemeral and intermittent channels slows erosion and fosters deposition of organic and inorganic materials. Deposited material becomes a source of food for macroinvertebrates both on site and downstream.” (USDA/USDI, 1998)

First and second order streams (typically, ephemeral and small intermittent streams) can have a major influence on downstream water quality wherever they comprise a significant part of the total stream miles in a planning area (USDI BLM, 2000). For example, in the Lower Applegate watershed analysis area most first and second order streams are characterized by intermittent and ephemeral stream flow (USDI BLM, 2000; 2003). In this mountainous terrain, the channels were found to be steep and V-shaped and capable of sediment transport. Large woody debris, which dissipates stream energy and slows channel erosion, was found to be an important component of low order headwater streams. Loss of woody debris due to past management has contributed to reduced channel stability and increased sediment movement downstream during storm events (USDI-BLM 1994).

The Oregon Forest Practices Act regulates activities on larger intermittent, perennial and fisheries streams on non-federal land. Those [Oregon non-federal lands] protections have been judged to be substantially less than what is necessary to meet regulatory, Endangered Species Act, and Clean Water Act requirements addressed by Resource Management Plan implementation for similar streams on BLM-administered land (USDI-BLM, 2006). Yet, this same management strategy, covering only fish bearing streams and larger intermittent non-fish bearing streams (and leaving out ephemeral streams) is exactly what is proposed for BLM lands in all three of the action alternatives of the DEIS. Although the Management Objectives for riparian zones call for providing “riparian and aquatic conditions that supply stream channels with shade, sediment filtering, leaf litter and large wood, and root masses that stabilize stream banks” (DEIS, 81) none of these protections has been proposed for ephemeral streams and stream channels.

Rather, by intentional omission, ephemeral streams have been designated as available for timber harvest, salvage operations and unrestricted disturbance by ground-based yarding equipment. To remedy this, all EIS alternatives should explicitly provide equipment exclusion protection against management disturbances to all ephemeral streams capable of sediment transport during design storm events (100-yr recurrence interval flows). RMA EEZ widths along ephemeral streams should be variable based on sideslope steepness and hillslope instability. At a minimum, the EEZ width for ephemeral streams should be 100 feet slope distance.

Alternative 3

The zone-specific management action for Alternative 3 Riparian Management Areas is similar to that for Alternative 2, except that no protection is provided for the steep debris-flow-prone stream channels. In addition, under Alternative 3 harvesting would not be allowed in the 25-foot RMA along non-fish-bearing intermittent streams.

The omission of protection for highly unstable debris-flow prone ephemeral and intermittent stream channels is a serious oversight, as described above. Each of the Plan alternatives, including Alternative 3, should provide maximum resource protection through the use of equipment exclusion zones and no-harvest zones that encompass debris flow origination sites (headwalls), transport corridors and run-out zones.

V. AFFECTED ENVIRONMENT

Water

The DEIS (Table 110) lists the designated perennial and intermittent stream miles that are within the BLM planning area. According to the DEIS (362), stream type and size are important because:

- BLM lands are more heavily concentrated in headwaters, typified by small, typically steep gradient high-energy streams.

- Forest roads cross small streams more frequently, which are potential sediment delivery points.
- Many small streams on BLM lands do not flow continuously by late summer.
- Small streams are important in determining the condition of larger streams and rivers.
- Floodplains are associated with larger streams.
- The BLM often manages a small percentage of the riparian areas along larger streams.

In spite of the fact that the DEIS has acknowledged that “small streams are important in determining the condition of larger streams and rivers” (DEIS, 43; 362), they have intentionally ignored the importance of ephemeral streams in their analysis. As described previously, this is a fatal flaw in the analysis of risk to resources resulting from all the proposed alternatives. The analysis presented in the DEIS cannot be considered viable when a significant component of the stream channel system, one that is disproportionately susceptible to mass wasting, has been left out of the analysis.

Road decommissioning

According to FEMAT (1993), road treatments to protect aquatic habitats fall into two categories: road decommissioning and road upgrading. Decommissioning has been defined as “removing those elements of a road that reroute hillslope drainage and present slope stability hazards. Another term for this is ‘hydrologic obliteration’” (FEMAT, 1993). It involves such tasks as fully excavating stream crossing fills (not just “culvert removal”), excavating unstable sidecast and road fill, decompacting road surfaces and installing road surface drainage (e.g., cross road drains or road outsloping). The decommissioning of unneeded, neglected, and high-impact roads may be one of the most urgent and significant restoration needs, based on the magnitude of ongoing and potential effects to aquatic ecosystems (FEMAT, 1993). Unstable, erodible and high risk (e.g., riparian) roads are prime candidates for decommissioning. Unneeded roads that pose little or no threat to aquatic resources can also be decommissioned but should not be targeted for decommissioning on the basis of aquatic protection or watershed restoration.

In contrast, road decommissioning is defined in the DEIS as the act of removing a road that is no longer needed for management purposes (DEIS, 795). This defined objective conflicts directly with the restoration and protection goals of FEMAT (1993) and overlooks the potential ecological benefit of road decommissioning. According to the DEIS, priority work for restoration, road maintenance, or road decommissioning would be given to projects that reduce chronic sediment inputs along stream channels and floodplains in source water areas (DEIS, 57). However, chronic sediment inputs from road surfaces and ditches are only one part of the sediment delivery equation for watersheds, and the DEIS alternatives have all overlooked the more biologically important benefits of road decommissioning. FEMAT (1993) outlines more specific priorities both to control ongoing erosion and to eliminate the potential for catastrophic failure that can devastate stream channels, aquatic resources, fish habitat, water supplies and other beneficial uses. These priorities include focusing road decommissioning on: 1) roads that are currently or potentially damaging to riparian and aquatic resources, 2) older roads located in sensitive (unstable and/or erodible) terrain, and 3) roads that essentially have been abandoned and have not been adequately treated for long term stability and drainage. In this way, road decommissioning is used as a tool for watershed and fisheries protection and restoration.

The Northwest Forest Plan 10-year monitoring effort for watershed condition found that the condition-scores of watersheds as influenced by roads generally did not change significantly since the Northwest Forest Plan was implemented (Gallo et al. 2005, as cited in DEIS (382))[1]. The BLM has acknowledged that the amounts of roads removed from any given watershed may have been relatively small and insufficient to change the watershed condition (DEIS, 382). This directly implies that past efforts at road decommissioning have not been significant enough nor strategically focused to have provided improved watershed conditions or enhanced watershed protection. Unfortunately, future BLM plans for road decommissioning as described in the DEIS action alternatives show no significant proposed increase in effort and no recognition that their method of prioritizing roads for decommissioning is fatally flawed as a watershed and fisheries restoration and protection tool.

According to the DEIS, the BLM has decommissioned approximately 590 miles of road. An additional 1,360 miles of BLM roads are identified for potential road closure (DEIS, 449). Road closure [undefined in the DEIS, but assumed to mean blocked or gated – not decommissioned] and decommissioning has led to a net decrease of 700 miles (5%) of roads on BLM lands within the planning area since 1994. These road closure segments were scattered with most being outside of the riparian reserves (DEIS, 382). Thus the most important roads and road segments to decommission, those located in sensitive riparian areas that have the potential to adversely affect high value streams, have been largely ignored and not included in this part of the BLM's road management and decommissioning program. Instead, the BLM has focused, and is proposing to continue its focus, on decommissioning roads that are no longer needed for management purposes. This strategy is not aimed at watershed restoration and improving watershed conditions and is likely the reason that no large net improvement has been observed in watershed conditions where decommissioning has already occurred.

In spite of this poor result, the proposed Plan and its action alternatives propose no greater effort at road decommissioning, and no better prioritization, than has occurred since the adoption of FEMAT in 1993. Thus, the poorly conceived rationale for decommissioning is proposed for continuation in the each of the Plan's alternatives: "Roads that are not needed for long-term management would be decommissioned. Roads would be temporarily closed or travel would be restricted for administrative and resource purposes" (DEIS, 43). The fact that "under all four alternatives, it is assumed that the decommissioning of existing roads would be completed within streamside areas in the same proportion as other roads" (DEIS, 762) (and hence not focused on high priority risk roads that threaten to fail and deliver large volumes of sediment to streams) confirms that the proposed RMP alternatives are not intending to use decommissioning as a serious and effective tool for the protection of watershed aquatic resources, water quality and listed fish species.

Road upgrading (stormproofing)

According to FEMAT (1993) road upgrading is done on roads that will remain open to control ongoing erosion and sedimentation and reduce the risk of future erosion and sedimentation.

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[1] Although the condition improvements were not large, this DEIS statement is not consistent with Gallos' findings: "Condition scores were generally higher in time 2 than in time 1; however, the magnitude of change was very small. The drivers condition score increased in 161 of the 250 watersheds (64 percent) by an average of 0.09 (SD 0.19; table 4). This level of change represents a significantly higher percentage of watersheds than would be expected if the changes were random ($Z = 6.25$, $p < 0.01$). (Gallo et al. 2005, p.27),

Preventing chronic erosion and reducing the risks of catastrophic storm-related erosion is feasible and cost-effective for many roads, and is described as "particularly important" because "catastrophic road-related erosion from large storms has been the most significant source of management-related aquatic habitat damage observed in many watersheds." In spite of this, the three DEIS action alternatives are silent as to the management objectives related to road upgrading and road stormproofing in the plan area.

Existing roads in the Plan area are extensive and in need of erosion control and erosion prevention treatments. The primary road road-related sediment sources and sites of erosion on these roads (DEIS, 375) include:

- Exposed road surfaces, including the road tread along with cuts and fills.
- Inadequate (infrequent) ditch relief culverts.
- Stream crossings that have undersized pipes or that traverse debris-flow streams.[2]
- Roads in upland areas that cross small seasonal streams more frequently, and so incur the greatest risk for failure.
- Road fill failures; particularly if they are within the slide-out range of a stream channel.
- Midslope roads, with steep and unstable road cuts and deep fills, pose the highest risk for landslides.
- Older roads that were sidecast constructed, built on fills with organic material, or crossed slide prone ground that have not yet failed are also at higher risk. In the Western Cascades province, road fill failures were found to represent the most frequent cause of debris flow initiation (Swanson et al. 1982, cited from DEIS, 375).

Despite the fact that these erosion and sediment delivery processes have been specifically identified as primary road-related sediment sources there is nothing in the RMP or in any of the Plan's action alternatives (Alternatives 1, 2 or 3) that quantifies the magnitude of these effects or recommends these sites for road upgrading and restoration treatment. Although these predictable and definable sediment sources are found all along the 14,000 miles of existing forest roads in the Plan area, there are no plans for addressing these ongoing threats. In fact, the terms "road upgrading" and "stormproofing" (proactive techniques for treating these sediment sources) are never employed in the body of the DEIS, and the only specific reference to this important activity occurs in one sentence in the Summary section: "Road improvements and the decommissioning of roads near streams would be of greater importance to decreasing fine sediment delivery than the effect of new roads" (DEIS, LXI). In spite of this statement, there are no management objectives and no management actions directed towards upgrading and stormproofing the existing 14,000 miles of existing forest road on BLM lands in the Plan area. This is a serious and fatal omission.

Road upgrading can result in greater resilience of forest roads systems. Two examples of reduced erosion and sediment delivery following recent road upgrading projects are described in the DEIS; one for Washington and a second one for ODF lands in Oregon (DEIS, 381). However, the DEIS provides no evidence that the same relationships occur on BLM lands in the Plan area nor more importantly do they propose an upgrading program for Plan area roads that might result

[2] We have assumed that stream crossing washouts and stream diversions, two important sediment source processes (e.g., see Furniss et al. 1997), are a subcategory of "stream crossings with undersized culverts."

in the improved performance (lower erosion and failure rates) that has been documented elsewhere.

The DEIS states that roads may be rebuilt to higher standards where they are damaged by floods (DEIS, 381), but is entirely silent about proactive measures and annual targets to reduce the threat of catastrophic road failures and the rate of sediment discharging from the thousands of miles of existing roads. This intentional omission is in conflict with the requirements and intent of FEMAT as well as the management objectives stated in the DEIS.

The omission of a road upgrading plan in any of the action alternatives under consideration has significant ecological implications for the aquatic system and for listed salmonids. The DEIS states that approximately 5,100 miles (36%) of the 14,275 miles of existing BLM road within the Plan area have been judged to deliver fine sediment to the stream network (DEIS, 376). The BLM sediment model has estimated that these existing roads deliver fine sediment to the stream network at a rate of approximately 11.8 tons/mi/year, or in excess of 60,000 tons of fine sediment every year (DEIS, Table 115). In the DEIS the BLM has only evaluated and discussed the plan alternatives in relation to the potential for increases in fine sediment delivery that are expected as a result of Plan implementation. The DEIS has not considered, nor has the BLM developed, management objectives or management actions to address the high rate of sediment that is currently pouring off the existing road network and into Plan area streams, including those containing listed salmonids and other beneficial uses. Water quality restoration and the restoration of stream complexity are explicit objectives of all four Plan alternatives (DEIS, 57). However, the lack of an aquatic conservation strategy within the plan that addresses threats and impacts from ongoing and proposed land management activities, including the existing road network, makes the DEIS and the proposed Plan incomplete and inadequate.

Hydrologic connectivity and fine sediment

Connectivity between roads and streams is the avenue whereby fine sediment eroded from roads and ditches is delivered to nearby stream channels. The DEIS has estimated that about 36% of the BLM road network is connected and draining runoff and fine sediment to streams. Connectivity is mentioned only three times in the entire DEIS document (DEIS, 373; 388; I-1108). Fine sediment is discussed in a number of locations, but generally in the context of the relatively small increase (<0.3%) that is expected to accrue from the new roads that are to be constructed under each of the Plan alternatives.

The DEIS analysis assumes that a 3.4% decrease in fish survival could potentially occur for every 1% increase in fine sediment from management activities (DEIS, 356). Rather than attempting to justify the proposed new road construction based on its estimated limited incremental effect on current rates of fine sediment delivery, the analysis in the DEIS should be employed to provide incentive to propose and plan a proactive aquatic conservation strategy and restoration program that would target the existing road network for dramatic decreases in fine sediment delivery. This could be accomplished quickly and cost-effectively by altering road surface drainage and dramatically reducing hydrologic connectivity between the existing road network and nearby stream channels. The estimated 36% connectivity that now exists between the road network and the stream system could be reduced to 10% with simple, effective and inexpensive treatments. According to the DEIS, the assumed reduction in fish survival (3.4% per 1% change in fine sediment) suggests that a focused sediment control program on the existing

Plan area road network could have significant positive effects on populations of listed fish species. Rather than look only to the adverse impacts of the proposed activities, the Plan should take advantage of the opportunities to diminish impacts from current and future management conditions and practices, as is currently required under the Northwest Forest plan. Unfortunately, none of the Plan action alternatives contain management objectives, management actions or targets for the reduction hydrologic connectivity and associated fine sediment delivery from the existing road network in the Plan area.

Derivation of fine sediment delivery volumes

There are several important factors employed in the DEIS modeling analysis that have likely resulted in a significant underestimate of the amount of fine sediment that will be generated and delivered to streams as a result of adoption and implementation of the Plan alternatives. These include: 1) failure to consider road maintenance, 2) oversimplification and underestimation of traffic volumes associated with all the Plan alternatives, 3) failure to evaluate winter hauling impacts on road erosion, and 4) underestimation of hydrologic connectivity of Plan area roads.

Road maintenance - The analytical technique used to provide estimates of fine sediment delivery from the forest road system is an empirical approach patterned in part from the Washington State Department of Natural Resources Standard Methodology for Conducting Watershed Analysis 1997, (v. 4.0), Appendix C. Based on existing literature (Swift 1984, Burroughs and King 1989, Sullivan and Duncan 1980, Megahan unpublished data) the DEIS indicates that proportions of the total long-term average road erosion rates attributed to the components of the standard road prism are: Road Tread - 40%, Road Cutslope and Ditch - 40%, and Fillslope - 20%.

In terms of actual sediment delivery to adjacent stream channels, most fine sediment probably originates from the road surface and ditch. Fine sediment is delivered from the road network through hydrologically connected road reaches. The amount of sediment produced from the running surface and ditch of a forest road is determined by the amount and type of traffic, maintenance disturbances, and other activities and site variables. Road maintenance activities in the Plan area include road surface grading and ditch cleaning (DEIS, 449). Grading in the Plan area is mostly concentrated on Level III roads that are used for commercial and other traffic (DEIS, 1191).

Traffic is often considered more important that ditch blading, but research indicates that ditch and road surface blading is highly correlated with sediment production. The combination of ditch blading and heavy traffic does not produce significantly more sediment than simply blading the ditch (Luce and Black, 2001). This finding has important implications for sediment modeling and is one factor that is likely to have resulted in a significant underestimate of fine sediment delivery. “Although the ditch grading effect is much larger, its effect is seldom accounted for in road sediment yield modeling whereas traffic effects generally are, if only as a traffic regime” (Luce and Black, 2001).

Traffic - Traffic levels are also highly correlated with fine sediment production and discharge. In calculating the amount of fine sediment delivery generated from the road network, traffic levels were assumed to be “moderate” (DEIS, 376). However, all three action alternatives call for greatly increased levels of timber harvest, and this can be expected to result in a concomitant increase in the amount of commercial log truck traffic and the ancillary traffic that is associated with all support activities. These increased levels of commercial and non-commercial traffic on Plan area roads have not been accounted for in the fine sediment analysis, and have likely resulted in an underestimate of fine sediment production and delivery from Plan area roads. Because the data have not been provided, it is unclear how great the impact will be under each of the proposed three action alternatives.

Winter log hauling – The timing of commercial traffic is often as important as the amount of traffic that occurs on a road system. The sediment analysis section of the DEIS does not directly evaluate the effects of winter log hauling and its potentially great effect on fine sediment generation and delivery to streams. Sediment impacts must account for the increased winter use of the existing road system on BLM and adjacent private lands and appurtenant road systems that are traversed. Depending on plans for winter operations, this omission is likely to have significant (but unknown) effects on the estimates of fine sediment delivery to stream channels for each of the three action alternatives.

Hydrologic connectivity – The estimated connectivity between roads and streams in the Plan area was derived from a modeling effort that assumed that all roads within 200 feet of a mapped stream would be hydrologically connected and would, therefore, deliver runoff and fine sediment to streams. The 200 foot connectivity assumption is sometimes used when data are not available for actual connectedness. This GIS-based analysis assumed that the road network and the stream network are accurately derived and portrayed on the landscape, and the number of road segments that cross streams is a function of the scale and accuracy of the GIS coverage. Using these assumptions, the model predicted that approximately 36% of BLM Plan area roads are hydrologically connected and drain to the stream system. In developing and applying the model a number of incorrect assumptions have likely resulted in a significant underestimate of road-related sediment delivery in the Plan area.

The degree of hydrologic connection between forest roads and streams is a function of several factors, including drainage density, road density and the hillslope position of the road networks. An important factor that influences drainage density, and hence hydrologic connectivity, is the actual frequency of stream crossings that are found along the road alignment. The model that was applied to the Plan area has provided a significant underestimate for several reasons. First, the model analysis was intentionally run using a data theme that only included intermittent and perennial streams. No ephemeral streams or crossings of ephemeral streams were included in the analysis. Secondly, even with the GIS stream layer maps that were used in the analysis there will always be a higher density of stream crossings in the field, and hence greater connectivity, as compared to crossing frequency that is derived from the remote-sensed GIS maps. Many of the smallest streams do not show up on maps that have not been completely field-verified. For these reasons stream crossing frequency and calculated hydrologic connectivity is almost certainly greatly underestimated in the DEIS analysis. The full impacts of the Plan's alternatives on stream sedimentation and water quality cannot be evaluated without reliable and accurate results.

The DEIS further incorrectly assumes that a road segment does not deliver sediment if the road does not cross a stream channel (DEIS, I-1107). Roads often discharge runoff and fine sediment into nearby streams without ever crossing the channel. For example, connectivity and sediment discharge often occurs where a road parallels a stream channel and road runoff discharges off the road and into the stream. Likewise, roads that are drained by ditch relief culverts or rolling dips all have significant probability of draining runoff directly into a nearby stream as runoff travels across the hillslope or in gullies extending downslope from the road drainage structure (Wemple, 1998). Roads that are as far away as 300 feet from the nearest stream channel can still deliver sediment to the channel through the connectivity provided by a gully that originates along the road. Research shows that even dispersed road runoff that is discharged from the road in rolling dips needs up to 100 feet of undisturbed filter to reduce the risk of sediment delivery to the stream ((Burroughs and King 1989). Thus, in developing and employing their fine sediment model, the DEIS assumes that concentrated and diffuse sources of sediment delivery are assumed to occur within 200 feet of stream channels (DEIS, I-1108)

Finally, the DEIS states that roads near ridges have little direct effect on sediment delivery to streams (I-1108). Although sometimes true, this is not always a valid assumption and has likely led to an underestimate of sediment delivery from the road system, and the resultant impact to aquatic resources and water quality. Roads near ridges can occasionally be 100% connected to the stream system, depending on road drainage and drainage density of the natural stream channel network. Upper hillslope areas often have relatively high drainage densities and a high frequency of small stream crossings as roads cross through the headwaters of many first- and second-order stream channels. Farther down the hillslope the stream channels become larger as the small channels merge into fewer large channels. In another section, the DEIS recognizes this and states that there are many more road crossings in these upper watershed areas (DEIS, 381). Because a stream channel is small and located high on the hillslope does not mean that sediment delivered from a road will not be transported to larger, more biologically sensitive streams farther downslope. The GIS mapping layer that specifically included only perennial and intermittent streams has added to this by grossly underestimating the density of small stream channels in the upper hillslope areas. The assumption that roads near ridges have little effect on sediment delivery is not valid, and has likely led to an underestimate of potential sediment delivery under the Plan's alternatives.

Omission of episodic sources of road-related sediment delivery

Other sources of road-related sediment production and delivery have been omitted from the DEIS analysis, and this calls into question the conclusions that have been developed for each of the alternatives.

All the previous fine sediment delivery estimates have focused on roads and the movement of fine sediment from roads to streams. Importantly, the DEIS analysis has overlooked and ignored the suite of episodic and catastrophic sediment inputs that originate from road failures during large storms. This type of sediment input is important, especially since 75% of the BLM Plan area road system goes without maintenance in any given year and any particular road segment receives road maintenance work only once every four years, on average.

Episodic road-related sediment sources have been well studied and described (e.g., Furniss et al., 1998) and are considered to be highly important sources of aquatic and fish habitat degradation in many watersheds (FEMAT, 1993). Episodic sediment sources include stream crossing washouts (failures), debris flows originating from stream crossing failures, road- and landing-related debris slides, debris flows originating from fillslope failures of roads and landings, and gullies and hillslope debris slides caused by stream diversions. Without consideration of the magnitude and impact of these sediment sources it is impossible to adequately characterize the environmental effects of any of the Plan's three action alternatives. The Plan and the DEIS are incomplete without this analysis.

Harvest-related sediment sources

The analysis of landsliding in the Plan area makes some of the same errors in analysis and presentation that were forwarded in the DEIS for road-related sediment delivery. The DEIS uses a disingenuous sleight of hand in their description of the effects of increased harvest rates on landsliding and landslide sediment delivery in the plan area. The DEIS discusses the potential effects in terms of "rates of landsliding" instead of the "number of landslides" or the "volume of landslide material delivered to stream channels" that is likely to result from the increased harvesting rates. Without a doubt, the number of harvest-related landslides that occur in response to large storms or that exist on the landscape at any point in time is going to be greater after any of the Plan's three action alternatives are implemented. This increase in landsliding will almost certainly have adverse impacts on many of the watersheds and in many of the stream channels where they occur. The scientific literature is unequivocal about this cause and effect relationship, although the magnitude of the expected effects cannot be estimated until the specific harvest areas are selected and analyzed.

The DEIS claims that under all four alternatives the rate of susceptibility to shallow landsliding from timber harvesting and road construction over the next 10 years would not increase, largely because the susceptible lands would be withdrawn (DEIS, 742; 763). However, under each of the three action alternatives an accelerated rate of timber harvesting is scheduled to occur. As a result, although the rate of landsliding (e.g., landslides/mile^2 of clearcut land) might not increase there will be many more harvested areas and hence many more harvest-related landslides at any given time. The rate of landsliding does not need to increase for there to be a significantly greater number of landslides on the landscape at any one point in time and a greatly increased adverse impact to aquatic resources and salmonid habitat.

All else equal, landslides occur more frequently on logged hillslopes that on hillslopes that have not been logged (Swanson and Dyrness, 1975; Swanston and Swanson, 1976; Amaranthus, et al., 1985). The DEIS does not analyze the expected effect of a great number of landslides that will occur in response to increased timber harvesting. Annual timber sale quantities can serve as a proxy for the relative amount of Plan area lands that will be disturbed (clearcut or otherwise harvested) and in a susceptible condition to landsliding following logging. Table 40 (DEIS, 112) indicates that compared to the no action alternative, Alternatives 1 and 3 will have about 1.7 times the amount of harvesting occurring each year the plan is operated. Alternative 2, the preferred alternative, has the highest rate of annual harvesting at over 2.7 times the current planned rate of the no action alternative. In a generalized sense, the number of management-related landslides that occur in response to this greatly increased harvesting should approximately mirror the increased rate of harvesting: 1.7 to 2.7 times the current landslide rate (# landslides/year). The DEIS has not presented an analysis of the environmental impacts of this expected increase in the number of landslides in each watershed and the sediment that will be delivered to streams as a result of the increased rate of harvesting. Such an analysis of landslide incidence would be absolutely critical to afford any accurate understanding of the environmental consequences of the alternatives in this DEIS.

Increased landsliding in the narrowed RMAs - Several other harvest-related elements of the Plan's three action alternatives are likely to result in increased landsliding, increased sedimentation and increased stream channel and aquatic impacts. Primary among these is the proposed narrowing of RMA widths under each of the three action alternatives. The current no-action alternative calls for a Riparian Management Area (RMA) width of 1 to 2 site potential tree heights and management within the RMA is designed to protect the aquatic resource values. Each of the three action alternatives have been designed to significantly narrow RMA widths and allow more active timber management alongside streams. Alternative 1 has been designed to reduce the RMA width by 50% as compared to the no action alternative, and timber management in the RMA is to be focused on promoting forest growth rather than aquatic conservation. Alternative 2 proposes to further shrink the RMA width, allows significantly more timber harvesting in the riparian area, and provides minimal debris flow protection of steep intermittent stream channels. Alternative 3 maintains the greatly reduced RMA widths of Alternative 2, but eliminates even the minor debris flow protective measures of the previous alternative.

Steep inner gorge slopes and steep slopes in riparian areas are highly susceptible locations for landslide origination. Implementation of any of the three action alternatives is almost assured to result in increased landsliding in and adjacent to the riparian management areas. Because of their proximity to streams, landslides in riparian areas have a greatly increased likelihood of delivering sediment to the stream channel system and impacting aquatic resources and fish habitat for listed species. The expected magnitude of this increased landsliding and resultant sediment delivery has not been analyzed in the DEIS and because of this it is impossible to evaluate the potential adverse effects of the RMA management associated with any of the three action alternatives (Alternatives 1, 2 or 3).

Broadcast burning - According to the DEIS, approximately 50% of the regeneration harvest units under all alternatives would be broadcast burned, and these burns are expected to be longer and hotter than if they were understory burns in a thinned stand. The intervening riparian management areas between regeneration harvest units and stream channels would remain unburned and would act as an effective filter strip and prevent sediment delivery (DEIS, 763). This management practice will result in increased mass wasting in the RMA-adjacent areas and (as previously described) the narrowed widths of the RMAs will not be sufficient to prevent sediment delivery from the adjacent harvested and burned hillslopes. In addition, there is no mention of how the BLM will keep the narrowed riparian areas adjacent to the streams from burning. They do frequently burn in practice, even when measures are taken to protect them and this is one central reason why federal agencies have moved away from broadcast burning under the Northwest Forest Plan. The DEIS fails to disclose the increased risk of fire in riparian zones that increased broadcast burning will cause.

VI. BEST MANAGEMENT PRACTICES (BMPs)

BMPs are defined as methods, measures, or practices selected on the basis of site-specific conditions to ensure that water quality will be maintained at its highest practicable level (DEIS, 1132). BMPs related to water quality should be viewed as standards which may require adjustment based on specific site conditions. A variety of BMP categories are listed in the DEIS appendices and a number of these have been reviewed in the following text. These include such management activities as road and landing construction, timber harvest activities, fire and fuels management, and restoration. Because the BMPs were not consecutively numbered in the appendices, each BMP that has been reviewed is listed verbatim with the review comment following the BMP.

According to the DEIS, BMPs may be modified in order to match effective BMP controls to the project design. The overall goal is not to adhere strictly to a particular set of BMPs, but to meet water quality objectives when implementing management actions (DEIS, 1134). The comments listed below are generally presented to show how a listed BMP is not workable, why it is not specific enough to be useful, why it is not sufficient to describe the desired outcome of the BMP activity, or why the proposed BMP is not actually a best management practice. BMPs typically should include statements, descriptive information and specifications that outline the methods for proper selection and implementation of the measure. Each BMP should include sections describing and detailing: 1) definition of the treatment, 2) purpose, 3) applicability (when to use it), 4) methods and materials, 5) maintenance, and 6) effectiveness. In general, the BMPs listed in the Plan and outlined in the DEIS are so brief and generalized as to provide little guidance or insight about their purpose, selection or applicability, proper installation, use, maintenance or effectiveness.

Best management practices (BMPs) are required by the federal Clean Water Act to reduce non-point source pollution to the maximum extent practicable (DEIS, 1132). Importantly, the required reduction in non-point pollution is to address all Plan activities and all Plan facilities, not just new activities and facilities. Yet most BMPs listed in the DEIS Appendix I refer to new road construction when road upgrading is likely to be a more widespread, necessary and common activity across the planning area. There are no management actions or BMPs listed for road upgrading and road improvement activities, and this is a serious and potentially fatal omission of the Plan and its action alternatives.

According to the DEIS, under all four alternatives, best management practices are proposed to be applied and are assumed by the BLM to maintain and improve water quality (e.g., DEIS, Appendix I, 1130). BMPs are more important than this statement implies. Federal regulations actually require BMPs to achieve these results; it is not sufficient to just assume they are being met through the application of these measures on the ground. The best management practices of the DEIS include methods that are supposed limit the delivery of sediment to streams from a variety of sediment sources (DEIS, LXII). These practices are applied during such management activities as timber harvesting, road maintenance and construction, road decommissioning, energy and mineral development, and fuel treatments (DEIS, 761). According to the DEIS, those BMPs that are necessary for typical situations have been included (DEIS, 1133). As described above, this is not the case.

According to the DEIS, the included BMPs are believed to cover most project activity situations in the Plan area (DEIS, 1134). However, the most glaring shortcoming of the Plan and its alternatives (including the Plan's BMPs) is the overt omission of a variety of important management objectives, management actions, and associated BMPs for controlling road-related erosion and sediment delivery. For example, road outsloping is not listed as a tool for drainage dispersal and sediment control on new roads or on roads to be upgraded. In fact, as described earlier, there are no specific BMPs for any road upgrading practices, and road upgrading is not listed as a category under Road and Landing BMPs project categories.

According the DEIS (761-762) some of the best management practices that are related to roads include:

- Reducing the number of new roads and reducing the stream fine sediment delivery points.
- Any new stream crossings would have sufficient cross drains commensurate with road slopes.
- Road systems improvements would reduce the flow of concentrated water and entrainment of fine sediment in roadside ditches by increasing drainage relief.
- Road restoration actions where roads are permanently decommissioned would disconnect road flow paths from streams. (761-762)

Yet even some of these generalized best management practices are flawed. For example, the number of new roads is not going to be reduced; new roads are proposed for construction under all the action alternatives. Similarly, to protect water quality, cross drains adjacent to new stream crossings need to be spaced and located with respect to hydrologic connectivity, not just road grade. These are simple examples that are repeated numerous times in the DEIS list of BMPs.

Table 271 – Roads and Landings

Location:

General - Many BMPs listed in this section do not appear to be obtainable or operable as stated. In fact, the first three on page 1135 are so restrictive as to not be believable. This calls into question the viability, utility and appropriateness of many of the listed BMPs. If these cannot be met, why were they written this way? Is there really a clear intent to accomplish these practices and meet these objectives? Adjustments to these stated BMPs would require large deviations from the stated BMP, and hence large deviations in the associated protection they are designed or purported to provide.

***BMP**:* Locate roads on stable locations without sediment delivery potential to streams (e.g., ridge tops, stable benches or flats, and gentle-to-moderate side-slopes). (1135) *This is an ideal objective, but probably not practically obtainable. Does this mean that roads will not be built unless they can be constructed on stable locations without sediment delivery potential to streams? There is no definition of an "unstable location" in the DEIS.*

***BMP**:* Avoid headwalls, old slump benches, geologic bedding planes, seeps, and steep channel-adjacent side slopes. (1135) *Old (ancient) slump benches are some of the better places to locate roads. Geologic bedding planes occur everywhere there are bedded geologic materials. If the bedding planes dip into the hillslope (as opposed to parallel to the hillslope) they are usually good locations to have roads. Finally, seeps are often ubiquitous on the landscape and it would often be impossible to completely avoid them in the field. Seeps on steep slopes are problematic, because they can cause landsliding, but there are standard engineering solutions to building roads near or over most seeps. In summary, these situations and conditions cannot always be avoided, and sometimes they are appropriate locations to build roads.*

***BMP**:* Locate new permanent roads outside of Riparian Management Areas, unless construction is under existing reciprocal road right-of-way agreements. (1135) *This BMP implicitly states that there will be no new stream crossings built where a new road would cross through a*

Riparian Management Area. This is a very protective proposal, but perhaps not obtainable unless all new temporary roads are ridge roads or very short spur roads located high on the hillslope.

Locate temporary road construction outside of Riparian Management Areas. Do not locate temporary roads parallel to stream channels and avoid new stream crossings. (1135) *There will be no new temporary stream crossings? This is a very protective proposal, but perhaps not obtainable unless all new temporary roads are ridge roads or very short spur roads located high on the hillslope.*

General Construction

General - There is no winter operating period specified. A number of construction measures and associated erosion control measures are discussed with respect to wet weather periods.

BMP*:* End-haul excavated material to minimize side-casting of waste material if side slopes generally exceed 60 percent, or where side-cast material may enter waterbodies, wetlands, or floodplains. (1137) *What is the definition of "generally exceed?" Sidecast material, by definition, is composed of loose uncompacted material sidecast onto a hillslope. Once beyond the angle of repose, it is unstable and subject to granular mass wasting. The gradient criteria should be more restrictive than listed because sidecast materials placed on slopes over 50% are likely to exhibit natural instability.*

BMP*:* Use only soil and rock materials in permanent road fills. Build up fills by layering; compact between 85 and 95 percent maximum density. Provide for additional fill drainage (e.g. use geo-textile fabrics, etc.) in landslide prone areas. (1137) *For proper compaction, soil layers should be developed and compacted in 6" lifts. Compaction testing standards should be specified so that compaction results can be verified. Typical field compaction techniques are not likely to achieve the stated compaction standards unless compaction equipment is employed.*

BMP*:* Use temporary sediment containment structures (e.g. silt fencing). (1137) *This BMP lacks standards for determining where or when such containment treatments will be used.*

BMP*:* Stabilize bare soil from construction prior to fall rains. (1137) *Again, the dates for the winter wet weather period need to be geographically specific. If it varied across the geographic area, then different areas may have different wet weather periods. These generalized wet weather dates can then be modified on a week by week basis based on weather forecasts*.

BMP*:* Seed and mulch cut and fill slopes, ditchlines, and waste disposal areas where soil will support seed growth upon construction completion. (1137) *Overall, from a water quality perspective, there is no need to seed and mulch bare soils that are not located where they would delivery sediment to a stream. In addition, whether or not you mulch a bare soil area should not be dependent on predicted seed germination and growth. All these bare soil areas should at least be mulched. Finally, only in extreme soil conditions (or on bedrock) will there not be a seed type that will germinate and grow to provide short term erosion control. Fertilizer may occasionally be required to achieve effective groundcover.*

***BMP**:* Clear channels/ditches above culverts prior to fall rains. (1138) *How far up will the channels be cleared? If the BLM is proposing to clear all channels of organic debris even for a short distance upstream from culvert inlets, then this is an ambitious task. What about the thousands of culverted crossings on existing roads; shouldn't these also be cleared and maintained free of culvert-plugging debris? The BLM description of "Input Variables" and "Causal Mechanisms" is significant, so the question then becomes "if the channels are not cleared as describe in the BMP, how will these serious and significant impacts be avoided?"*

Surface Drainage

General - The primary "causal mechanism" listed for every BMP in this section is to achieve "effective surface drainage to the forest floor, preventing sediment delivery to stream channels." This is an appropriate objective but many of the listed BMPs are not adequate to achieve the stated objective.

***BMP**:* Provide effective drainage away from the road surface in maintained ditches on crown and ditch roads. (1138) *Poorly worded BMP will lead to misinterpretation in the field. "Crown and ditch roads" is not a clear term. All road shapes, including those that are insloped, outsloped and crowned, should be effectively drained. "Drain the road surface quickly and effectively by the use of crowning, insloping and outsloping" would be a clearer statement of intent.*

***BMP**:* In-slope low traffic volume roads where the road footprint or underlying soil formation is very rocky, not erodible or subject to failure. (1138) *This is poor conceived and/or written "BMP" that is likely to lead to increased sediment delivery to streams. Where the fillslope is potentially unstable, insloping can be used to divert road surface runoff to adjacent, satble hillslopes. However, low volume roads in almost all other soils should be outsloped unless there is a specific traffic hazard from this road shape. Insloped roads are more likely to be avenues for stream diversions. They are also more likely to result in the collection and concentration of road surface and cutbank runoff and then discharge it at discrete locations where gullies can form or where fine sediment can be discharged to steam channels. In all but a few circumstances, low volume roads should be outsloped because this road shape requires less maintenance and has less environmental impact. Even if there is significant seepage and spring flow from the cutbank, the adjacent road surface can still be outsloped while an inside ditch is used to drain onlt the clear water from the cutbank. The "Best Management Practice" is to outslope low volume roads wherever possible, especially when they are located on stable, rocky soils.*

***BMP**:* Out-slope low traffic volume roads to provide surface drainage on road gradients less than 8 percent, where an inside ditch is not planned. (1139) *Low traffic volume roads should be outsloped up to 12% road gradient. Low traffic roads that are steeper than 12% can also be outsloped in many locations. Moderate and high traffic roads can be outsloped or crowned on slopes less than 8%. One size does not fit all when it comes to road shape. A single high traffic road can have insloped, outsloped and crowned sections along its length to maximize effective road surface drainage. This BMP should be rewritten to address outsloping strategies and techniques for all road types.*

***BMP**:* Use rolling drainage dips and/or lead-off ditches as options in lieu of culverts for low traffic volume roads with less than 10 percent gradient or where blocking roads is a road management objective. (1139) *The objective should be to reduce or eliminate traffic impacts on low standard roads. Gating is appropriate, but blocking roads should not be a management objective, unless the road does not have stream crossings requiring maintenance. If a road is physically blocked, it cannot be easily inspected and maintained in the winter months. Not maintaining stream crossings can lead to serious erosion and downstream impacts. It is a fundamental BMP that all roads should be maintained, and those that aren't maintained should be decommissioned. This should be clearly and unambiguously stated in the DEIS section dealing with road management.*

***BMP**:* Locate surface water drainage measures (water bars, rolling dips, etc.) where water might accumulate, or where there is an outside berm that prevents drainage from exiting the roadway. Install during the dry season. (1139) *The BMP is poorly written. First, new roads should not be built with outside berms that prevent road surface drainage. Wherever there is a berm that prevents drainage of the road surface, it should be breached or removed. Secondly, there are many other locations where roads should be drained that are not points of "accumulation" or where there is an impeding berm. This BMP should be rewritten with intent language as follows: "Surface water drainage measures (structures) should be located where they will drain the road surface without delivering sediment to a stream or water body, and at frequencies that are sufficient to prevent damage or serious erosion of the road surface." This makes it clear that road surface drainage should be designed to protect water quality (first) and road bed integrity (second).*

***BMP**:* Prevent diversion of water from streams into road ditches. (1139) *Diversion should be prevented down road surfaces and ditches (not just ditches). This BMP should apply to all roads, both new construction and existing roads. This seemingly innocuous BMP is one of the most important water quality protection measures in the long list of BMPs in the Plan, yet it provides no actual specifications for accomplishing this task. The listed causal mechanism, ditch erosion and consequent sediment delivery, is one of the less important adverse results of stream diversion, others being hillslope gullying and the triggering of large debris landslides. These management concepts were identified 20 years ago and have been viewed as USFS and industry standard BMPs for at least a decade (Hagans and Weaver, 1987; Weaver et al., 1995; Furniss et al., 1997; Furniss et al., 1998).*

***BMP**:* For roads involving very erodible soils near streams:
• Construct 75 feet lead-in ditch to catchbasins
• Require rock armoring of lead-in ditch for through fills greater than 6 feet in height
• Design catch basins in a manner that would settle out transported sediments.
• Maintain these basins. (1139)
Ditches should be minimized or eliminated in areas of highly erodible soils. If ditches are used, they should only carry flow from seeps and springs on the cutbank; not from the road surface. Wherever possible, outsloping should be the preferred road surface drainage treatment employed in areas of highly erodible soils. This minimizes concentration and collection of road surface runoff and reduces the potential for resultant gullying. Even where ditches are required, the road surface should be outsloped so as to reduce the collection and concentration of ditch flow on the highly erodible soils.

Cross Drains

BMP*:* Locate cross drains at intervals sufficient to prevent water volume concentration and accelerated ditch erosion. (1140) *As a BMP providing for the protection of water quality, cross drain spacing needs to consider both location of the discharge point and spacing between the drains. The location of cross drains should be determined such that runoff and sediment is not discharged to a stream. While accomplishing this water quality objective, the spacing of cross drains should be such that erosion of the road and ditch is minimized or eliminated. Roads which utilize an inside ditch should have ditch relief culverts (cross drains) located and spaced at intervals sufficient to prevent gullying and the discharge of road surface runoff and associated fine sediment to watercourses. If prevention of such discharge is not feasible, ditch relief culverts shall be spaced at intervals no greater than those required to prevent road and ditch erosion, and additional sediment control measures should be taken to minimize fine sediment delivery. These measures include outsloping of the road surface (to separate road surface runoff from the ditch), use of ditchline settling basins, and/or the use of culvert endcaps and perforated flex pipes on the discharge end of the ditch relief culverts to disperse culvert discharge at locations close to stream channels.*

BMP*:* Construct cross drainage culverts or drainage dips immediately upgrade of stream crossings to prevent ditch sediment from entering the stream. (1141) *The two types of drainage structures drain different parts of the road prism. Generally, culverts drain the ditch and rolling dips drain the road surface. It is important to divert both ditch sediment and road surface sediment off the road prism prior to stream crossings and stream channels. Thus, both culverts* ***and*** *drainage dips (or other road surface drainage structures) should be constructed immediately upgrade from stream crossings to reduce hydrologic connectivity.*

BMP*:* Place protective rock at culvert entrance. (1142) *Ideally, there should not be enough water flow in a properly installed ditch relief culvert to require it to have armor at the inlet. If armor is required to prevent erosion, it usually means that there is too much flow in the ditch and/or the culvert has not been installed at the recommended 30 degree angle to the road, thereby minimizing the turn the flow has to make to enter the culvert inlet. It is a waste of valuable time and resources to armor the inlet of all ditch relief culverts. It is a treatment that is rarely or very occasionally needed.*

Stream Crossings

BMP*:* Install all crossings during the low flow period (generally June 15 to September 15). (1142) *This BMP is generally appropriate, but lacks specificity and guidance about the best (most suitable) conditions for stream crossing installation in individual stream channels. Ideally, stream crossings should be installed when the channel is dry. For intermittent streams with extended flow, and for perennial streams, crossings should be installed during the lowest flow period of the year, preferably towards the end of the summer period in August or September. To maximize protection of water quality, crossings of these watercourses should not occur early in the summer (June) when flows are still relatively high compared to later in the summer.*

Permanent Stream Crossings

***BMP**:* Size culverts, bridges, and other stream crossings for the 100-year flood event (including allowance for bed load and small floatable debris) without exceeding capacity or diversion. Match culvert width with active channel width. (1143) *There are no criteria in this BMP that describes the methodology that will be used for culvert sizing "including allowance for bed load and small floatable debris." This stream crossing sizing criteria has been addressed by Cafferata, et al. (2004) and similar quantitative criteria should be included in this BMP standard. The practice or standard of matching culvert width with active channel width is appropriate for reducing the potential for culvert plugging, but the BMP as stated leaves no flexibility for very wide, shallow channels.*

***BMP**:* Limit the number of new stream crossings. (1143) *This BMP provides no standards that would make it a "Best Management Practice." As a possible standard or target for the BMP, it could be stipulated that stream crossing density for a watershed or watershed management area shall be limited to a certain frequency (#/mile) or density (#/mi^2) that is targeted at lowering the current density of crossings, or to a number lower than that which has been determined would otherwise impact aquatic resources and water quality. That number will likely be different for different watersheds and would be based on the resources and beneficial uses being protected as well as current watershed condition and water quality impacts. Operationally, if a proposed road cannot be constructed that would meet this target, then the road would not be built or an alternative route would be selected that would have fewer crossings and less impact while still meeting the target watershed standards. As stated, there is really no upper limit to the number of new stream crossing that could be built.*

***BMP**:* Construct the stream crossing approach at a right angle (or as near a right angle as possible) to the stream. (1143) *On deeply incised streams, this BMP would result in large volume stream crossing fills. Preferably, the BMP should be aimed at minimizing stream crossing fill volumes should be minimized so that when they do fail and washout, stream crossing erosion and downstream sedimentation is minimized. This can be accomplished by: 1) site selection (selecting benched, unincised or topographically shallow crossing sites) or 2) construction techniques (dipping the road down into and across the stream, and/or following the sideslope contours by curving in and out of the crossing site). The latter alternative is preferable to straight-across stream crossing construction at locations where deep canyons are to be crossed. If the steep sideslopes are stable then the approach road on the channel sideslopes can be constructed using full bench endhaul construction methods and avoiding sidecasting. These are all standard construction techniques, but the proposed BMP does not reflect or acknowledge other methods that might be more suitable at sensitive crossing sites. If a goal of the BMP is to protect water quality and aquatic habitat, then the BMP should be aimed at minimizing fill volumes and sediment delivery potential, not at constructing the crossing at a certain angle to the stream.*

***BMP**:* Locate culvert placement on a well defined, unobstructed, and straight reach of stream. Avoid locations that require a stream channel to be straightened beyond the length of a culvert. (1143) *A straight reach is preferable, but sometimes a bend in the channel cannot be avoided or construction at this location would have less of an impact than moving the road elsewhere. In this case, the inlet of the culvert should be placed in alignment with the upstream channel and* *armor can be placed where the culvert outlet would otherwise discharge into an erodible bank. Proper inlet orientation helps minimize culvert plugging potential. Alternatively an elbow can be placed at the culvert outlet to turn streamflow back into the natural channel. Always, the most stable and least damaging alternative should be selected.*

BMP: Do not install culverts on fill material in ephemeral or intermittent channels. (1143) *Culverts in all streams (<u>including perennial streams</u>) are best placed on the original streambed.*

BMP: Use containment and filtering techniques (e.g., bladder barriers, silt curtains etc.) if diversion is not possible. Place sediment controls along <u>or</u> immediately downstream of the instream work. (1144) *Sediment controls should be placed at both locations. Thus, "Place sediment controls along <u>and</u> immediately downstream of the instream work." A sediment control structure should always be placed in the channel immediately downstream from the culvert installation work site.*

BMP: Countersink culvert below the streambed. Increase culvert diameters accordingly. (1144) *This "BMP" does not provide sufficient guidance for application purposes. How far should it be embedded? Should the degree of countersink be different for fish bearing streams than for other streams? How much should the culvert diameter be increased? What if the streambed is on bedrock?*

BMP: Use stream crossing protection (e.g., hardened crossing, fill armoring, grade dipping, etc.) where high debris loads are expected (such as debris torrent channels) to allow overflow without loss of the fill. (1145) *The final part of the BMP should be modified to account for the consequent high likelihood of stream diversion under conditions of "high debris loads." The wording should read as follows: "Use stream crossing protection (e.g., hardened crossing, fill armoring, grade dipping, etc.) where high debris loads are expected (such as debris torrent channels) to allow overflow without loss of the fill <u>or diversion of streamflow</u>." (addition is underlined). The dip in the road should occur off-line from the stream channel so that it is not filled and plugged by the debris flow.*

BMP: Provide adequate stream bank protection using bioengineering techniques (e.g., rock and/or organic material) where bank erosion would occur. (1145) *The BMP needs to be reworded to show intent and to capture the requirements of a biotechnical system. Soil bioengineering combines the use of live plants or cuttings, dead plant material, and inert structural members to produce living, functioning land stabilization systems. Neither "rock" nor "organic material" by themselves or in combination are bioengineering techniques, unless they are used in conjunction with living materials. If the BMP is for the use of bioengineering techniques to control bank erosion, then the application of rock armor and or buttressing with organic material would not qualify unless it was employed in combination with living plant material.*

BMP: Place energy dissipators (e.g., large rock) at the outlet of culverts on streams. (1145) *The use of rock armor at culvert outlets would <u>not</u> be an appropriate treatment on most culverted fish-bearing streams. In addition, culverts that outlet into bedrock or otherwise naturally armored channels usually do not require the placement of additional rock armor.*

BMP*:* Incorporate additional design criteria (e.g., rock blankets, buttressing, relief pipes higher in the fill, etc.) for deep fills to lesson the susceptibility of fill failures. (1146) *When properly constructed, deep fills are not unusually susceptible to fill failures. For this reason, guidance is needed on when to use these measures and when not to use them. The BMP does not provide practical guidance about the depth or characteristics of a fill that would generally trigger the use of these protective measures, nor does it give guidance on how and where to use the listed BMPS. For example, there are no BMPs or guidance specifications for the location and sizing of emergency relief culverts in deep stream crossing fills.*

BMP*:* Use slotted risers, trash racks, or over-sized culverts to prevent culvert plugging in areas of active debris movement. (1146) *Slotted risers provide less capacity than an open barrel culvert, and thereby increase the likelihood of culvert plugging. They do not "prevent culvert plugging." Other inlet structures such as beveled culvert inlets, flared inlets and wing walls can locally be employed to reduce the potential for culvert plugging.*

Temporary Stream Crossings for Roads and Skid Trails

General - Temporary stream crossings should be designed to accommodate the design flow for the period of use and the climatic regime of the site. If temporary stream crossings are to be kept in place over a winter period, they should be designed and constructed to the same standards as permanent crossings.

Low-Water Ford Stream Crossings

BMP*:* Use materials that would withstand 100-year flow events (e.g., concrete, well anchored concrete mats, etc.) on permanent crossings. (1148) *Low-water ford crossings on fish bearing streams should be designed and constructed so as to allow fish passage for all life stages.*

Road Use and Dust Abatement

BMP: Avoid wet season (generally, November through April) hauling on unsurfaced roads. (1148) *Large quantities of fine sediments are also generated from commercial log truck traffic on rock surfaced roads during the wet weather periods. Thus, there should also be hauling restrictions on rock surfaced roads and road segments that are hydrologically connected to stream channels. Wet weather hauling should cease at such time that hydrologically connected road surfaces and ditches exhibit flowing turbid water (i.e., before there is discharge to a stream or water body).*

BMP*:* Apply structural treatments (i.e., adjust frequency of cross-drain spacing, sediment barriers or catch basins, gravel lifts or asphalt road surfacing at stream crossing approaches, and clean and armor ditchlines) for winter hauling. (1148) *First, as described above, rock-surfaced roads should be closed to wet weather hauling when they exhibit turbid outflows in areas connected to streams. Second, the list of surface treatments to minimize discharge of runoff and fine sediment to stream channels should also include road surface shaping, such as outsloping and rolling dips. Finally, cleaning ditches is more likely to increase sediment delivery to stream* *channels than it is to control or reduce sediment delivery. Armoring ditches should not be necessary if ditchlines are short and of limited drainage area. Once a ditchline is armored, it can no longer be cleaned by grading and maintenance becomes very difficult. Preferably, most ditchlines should not discharge to streams and those short sections that do connect to streams should be vegetated (not rocked) to slow flow and encourage sediment deposition. Road surface outsloping along reaches with connected ditches can effectively separate road runoff from ditch flow and keep ditch runoff relatively free of sediment.*

***BMP**:* Suspend timber hauling during wet weather when road runoff delivers sediment at higher concentrations than the existing conditions in the receiving stream. Hauling could resume when ditch flow subsides, or when conditions allow turbidity standards to be met. (1149) *This BMP assumes that the existing turbidity in the stream is at background levels, or that the only goal of a BMP is to not increase turbidity. Many streams are already degraded and impacted by elevated turbidity and suspended sediment. This BMP, as stated, is aimed at maintaining the current level of degradation rather than improving water quality conditions. Fine sediment delivery from roads is not a background or natural sediment source; it is entirely human-caused. Therefore, the BMP (Best Management Practice) should be to use treatment techniques that greatly reduce or eliminate fine sediment delivery from roads.*

***BMP**:* Use water or approved surface stabilizers/dust palliatives to reduce surfacing material loss and buildup of fine sediment that may wash off into waterbodies, floodplains, or wetlands. (1149) *The stabilizers and palliatives should not only be approved, they should be biologically inert, proven to be harmless to aquatic resources and suitable for public recreation and consumption (depending on the beneficial uses of the waters to which it is discharged).*

Maintenance

***BMP**:* Avoid undercutting of cut-slopes when cleaning ditchlines. Seed and mulch bare soils. (1150) *Revise to read: "Seed and mulch bare soils, including cleaned ditchlines." Ditchlines, especially those that are hydrologically connected to stream channels, should be seeded after they are cleaned so that they become more efficient sediment traps and deliver less sediment to streams.*

***BMP**:* Blade and shape roads to conserve existing aggregate surface material, retain the original crowned or out-sloped self-draining cross section, prevent or remove eroding berms (except those designed for slope protection) and other irregularities that retard normal surface runoff. (1150) *Add a seasonal restriction to road surface grading, just as with ditch cleaning. "Blading and shaping of road surfaces shall not occur during the winter period or during wet weather conditions."*

Closure and Decommissioning

***BMP**:* Decommission new roads not included in the permanent road system upon completion of use, or stormproof if needed the following season. (1150) *There is no definition for "stormproofing" of roads and road systems in the DEIS. If the environmental benefits of* *stormproofing are comparable to decommissioning (and we assume it is because it is listed as an alternative treatment here) then the BMPs for stormproofing need to be spelled out in detail in the DEIS. Upgrading or "stormproofing" roads is a process that is formally described in significantly greater detail elsewhere (e.g., FEMAT 1993; Weaver and Hagans, 1999; Weaver et al., 2006).*

BMP: Decommission older, under used roads that require high maintenance where regular maintenance is unlikely to occur due to lack of resources. (1150) *These criteria for selecting roads for decommissioning are not consistent with the concept of resource protection. Maintenance costs, age and under-utilization are not, in-and-of-themselves, useful ranking criteria if the primary goal of road decommissioning is to limit degradation of water quality and impacts to aquatic resources. According to FEMAT, "Decommissioning means removing those elements of a road that reroute hillslope drainage and present slope stability hazards." This is the commonly accepted functional definition of road decommissioning. "Road decommissioning: includes closing and stabilizing of a road to eliminate potential for storm damage and preclude the need for maintenance…" (FEMAT Report, Appendix V-J). Maintenance costs enter the picture largely because decommissioned roads will no longer require maintenance. The FEMAT Report identifies dual criteria for road decommissioning, but focuses on the ultimate rationale of resource protection: "Unneeded roads and roads that are currently or potentially damaging to riparian and aquatic resources should be removed or restored to control ongoing erosion and eliminate the potential for catastrophic failure." (FEMAT Report, Appendix V-J).*

In the DEIS the BLM should develop prioritization criteria that can be used for determining what roads should be decommissioned, and in what order under the proposed Plan. The priority should be based on environmental risk and potential of ongoing downstream impacts, as well as the cost of maintaining the road. Once formal ranking criteria are established for the Western Oregon region, the BLM should then identify and prioritize (rank) roads for decommissioning within each management district and within each biologically important watershed. In this manner, the most important, highest impact roads are removed from the system first, and those roads that are under used but of low environmental significance are placed lower on the priority list. The current plan for decommissioning "older, under-used roads that require high maintenance where regular maintenance is unlikely" is neither appropriate nor justified.

Decommission to Level 1 and any other appropriate level as described below.

General - The "Levels" that are described here are not levels of road decommissioning; they are a variety of techniques used for closing (blocking) or decommissioning roads. As written Level 1 decommissioning is portrayed as the basic "decommissioning" technique that is appropriate in most situations, and that other more intensive measures (Levels 2 – 5) can be added on "as appropriate." This is a completely misleading guidance statement, in that "Level 1" is not a decommissioning technique; it just consists of blocking or gating the road from traffic.

There are no decision-criteria that give guidance to land managers about the "appropriate level" of decommissioning to seek in various landscapes, watersheds, hillslope positions and road system conditions. This critically important and essential decision-making standard has not be defined or elucidated in the DEIS BMP. For example, under what conditions is each "level" of decommissioning appropriate? When would they be recommended? Under what conditions would each "level" be prescribed? This standard is perhaps the single most important element defining the effectiveness of road decommissioning in impacted watersheds. The DEIS provides no guidance in this BMP and for this reason it is useless and misleading as listed.

***BMP*: Level 1:** Gate or block roads not needed, but not recommended to be fully decommissioned. (1151) *These two actions (gating and blocking) do not fit the definition of "decommissioning" as listed in FEMAT and the scientific literature, and as such should not be listed as a decommissioning treatment. "Road closures with gates or barriers do not qualify as decommissioning or a reduction in road mileage." (April 13, 1994, Standard and Guidelines, FEMAT ROD for Amendments, page B-19).*

***BMP*: Level 2:** Remove stream crossing culverts and in-channel fill material during low flow (generally, June 15 to September 15) and prior to fall rains. Pull back road fill to match channel widths and establish former drainageways when removing culverts. (1151) *Unless the channels are dry, decommissioning is usually recommended to occur at the end of the summer season, during the lowest period of flow (August and September). Channel width within decommissioned stream crossings should be designed and constructed for the 100 year flood flow, just as is required of culvert diameter on newly built roads.*

***BMP*: Level 2:** Reestablish stream crossings to the natural stream gradient. Reestablish stream side slopes to the natural contour. (1151) *Gradient: Reestablishing the original channel gradient is not as important as removing the entire fill. Thus, the original channel bed should be exhumed, and all fill materials that were filled on-top of the former stream bed during road construction should be excavated and removed. Sideslopes: Sideslopes on decommissioned stream crossings should be excavated back to a 50% gradient, or to the original sideslope gradient. Excavated sideslopes should be straight or slightly concave in profile; not comvex. Justification - Slopes that are 50% or less are typically stable within most geologic materials and can be further stabilized with non-tacked straw mulch and seeding. Steeper sideslopes are more prone to erosion and mass failure. Likewise, sideslopes that are convex in profile tend to be steeper near the channel bottom and are more prone to undercutting and mass wasting during winter flows. Straight or concave sideslope profiles are more stable and less prone to erosion and failure.*

***BMP*: Level 2:** Waterbar decommissioned roads on each side of stream crossings. (1151) *Road surface drainage structures used on decommissioned roads must remain functional in perpetuity; thus they must be sizeable, functional and relatively self maintaining. Waterbars are relatively small drainage structures that are typically used on seasonal, unsurfaced roads. They can be broken down over time by foot traffic, OHV traffic, animals, and natural erosion processes. In contrast, cross ditches (or cross road drains) are large, oversized waterbars or ditches that drain the road surface. Oversized cross dips can also be constructed with the same function and resilience. Both are large enough that they cannot be driven over and they are substantial enough that they meet the definitions of a permanent road surface drainage structure. Waterbars are not usually appropriate for permanent road decommissioning.*

***BMP*: Level 3:** Seed and mulch the road surface, where erosion could occur. (1152) *This is a poorly envisioned and conceived BMP. Except in highly unique situations, all decommissioned road surfaces will largely consist of bare erodible soil, and soil erosion will occur on all such decommissioned road surfaces. Following this Level 3 BMP would mean that all* *decommissioned road surfaces will automatically be seeded and mulched. The purpose (causal mechanism) listed for this BMP is to keep eroded sediment out of stream channels. A more appropriate BMP would therefore be: "All hydrologically connected bare soil surfaces on decommissioned roads shall be seeded and mulched prior to the first winter period." Finally, the BMP does not indicate the rate of seeding and mulching of, alternatively, the coverage that is to be attained as a result of implementing the practice.*

***BMP**:* **Level 4:** Till the roadbed, landings, and construction areas. (1152) *The proper guidance criteria and general specifications are lacking from this BMP. Road tilling (better known as decompacting, ripping or subsoiling) should be done to a depth of 24 to 36 inches to be effective and increase infiltration (Luce, 1997). Decompaction should be performed on compacted road surfaces, including decommissioned road surfaces that are to be outsloped and/or used for spoil disposal. The current BMP is inadequate to provide sufficient guidance on proper techniques and situations for road decompaction.*

***BMP**:* **Level 5:** Pull back road fill and recontour to the natural slopes. (1152) *At first glance this BMP appears to call for road obliteration: pulling back the sidecast fill and placing it back (recontouring) against the cutbank until the original slope has been restored. This is an unusual decommissioning technique that is typically reserved for roads in park lands and wilderness areas where topographic obliteration is desired. However, the Causal Mechanism for this BMP refers to "water concentration eroding compacted surfaces" resulting in sediment delivery to streams.*

The BMP and the Causal Mechanism as it is written completely misses the point of this road decommissioning treatment. Road fill is "pulled back" (better described as "excavated") wherever the fillslope is unstable or potentially unstable and failure of the unstable fill material by mass wasting could cause sediment delivery to a stream (FEMAT, 1993). Road fill is rarely "pulled back" to prevent erosion, as implied in the Causal Mechanism. In addition, there is no guidance or specification provided in the BMP as to the techniques that are best employed to minimize the potential for future slope failures and associated sediment delivery from excavated fillslopes.

***BMP**:* Stormproof open roads not scheduled for planned maintenance. (1153) *The DEIS contains no definition or specifications for road "stormproofing." This "BMP" is without context, purpose or methodology and needs full description, including appropriate situations and techniques, before it can be considered a Best Management Practice. As defined elsewhere, stormproofing is group of road upgrading techniques that result in reduced chronic road erosion and sediment delivery as well as making the road more resilient to storms and floods. A suite of specific storm-proofing practices have been described in the literature (FEMAT, 1993; Weaver and Hagans, 1999; Weaver et al. 2006).*

Water Source Development and Use

General - In this section there is no discussion about the Best Management Practice for developing and drafting water from fish bearing stream channels or in streams that ultimately affect downstream fish habitat. Clearly, fish passage and water quality protection must be accounted for in all water use operations. In addition, there are no BMPs for water extractions rates in either fish-bearing or non-fish-bearing stream channels so as to minimize the adverse impacts of artificial drawdown on aquatic life, including fish. This BMP is incomplete as stated.

Table 272. Best Management Practices for Timber Harvest Activities

***BMP**:* Require full suspension over flowing streams, non-flowing streams with erodible bed and bank, and jurisdictional wetlands. (1155) *Full suspension should also be required over the immediate sideslopes to flowing and non-flowing streams, not just the bed and banks. These steep sideslopes typically have an erodible soil cover even if the channel bed and bank are composed of bedrock. Scarring and disturbance to these sideslopes will result in erosion, turbidity and sediment delivery to the stream channel.*

***BMP**:* When operating within riparian management areas (1155):

- Avoid construction of new skid trails by preferentially using existing skid trails. (1155) *Sometimes it is not appropriate to use existing skid trails. Existing skid trails may be used if and where their use will be less detrimental to water quality and slope stability as compared to construction of new skid trails or use of alternate yarding methods. Existing skid trails should not be used if they show signs of instability. Where they are used, there should be no sidecasting on existing skid trails in the RMA.*

- In previously un-entered stands, use designated skid trails to limit soil compaction to no more than 12 percent of the harvest area. (1155) *The definition of a "designated skid trail" has not been provided. If the stand is "un-entered" then there would most likley be no existing skid trails and it is assumed that designated skid trails are those that have been specifically flagged in the field for use in the proposed yarding operations. Finally, the origin of the 12% compaction target is not identified or technically supported in this BMP. If it is related to changes in post-harvest runoff and peak flows, then the number should be academically supported, and each soil type would likely have a different factor.*

- Site-specific conditions, such as shade retention or soil erodibility, may require a ground-based equipment exclusion zone (50 to 75 feet) adjacent to waterbodies, floodplains, and wetlands to provide filtration and shade retention. (1155) *All stream channels and immediate sideslopes within harvest areas should be provided physical protection from yarding and harvest related activities. This is accomplished by equipment exclusion zones (EEZ) and is the only way of assuring that direct disturbance of stream bed and banks and soil erosion on streamside slopes will be avoided or minimized. Equipment Exclusion Zone (EEZ) means the area where heavy equipment associated with timber operations is totally excluded for the protection of water quality, the beneficial uses of water, and/or other forest resources. As an erosion control and water quality protection measure, equipment exclusion zones should be provided for all perennial, intermittent and ephemeral streams capable of sediment transport. The EEZ width should increase with increasing sideslope gradient and should not be limited to a maximum of 75 feet.*

Table 274 – BMPs for Fire and Fuels Management - Wildfire: Suppression

BMP*:* Implement emergency fire rehabilitation treatments to accomplish erosion control as quickly as possible and before the wet season. Examples include:

- Use native or other ecologically appropriate vegetation for short-term cover development and long-term recovery.
- Mulch with straw or other suitable material.
- Use straw wattles.
- Install log erosion barriers.
- Spread slash on bare soils.
- Place channel stabilization structures.
- Place sediment retention structures in channel.
- Place trash racks above road drainage structures.
- Install drainage structures, such as water bars or drainage dips, on firelines, fire roads, and other cleared areas according to guidelines in *Table 5* (Waterbar spacing by gradient and erosion class).
- Repair damaged road drainage facilities.
- Block or decommission roads and trails. (1164)

1) BMP effectiveness *- A number of the "emergency fire rehabilitation treatments" listed above have not been shown to be cost-effective in field application and the effectiveness of the applications are highly variable (Robichaud et al., 2000; MacDonald, 1989). For this reason, the laundry list of post-fire treatments is not considered a list of BMPs. Hillslope treatments have a wide range in effectiveness, ranging from effective mulching (Rough et al., 2004; Wagenbrenner et al., 2006) to comparatively ineffective straw wattles (Robichaud et al., 2000). Channel treatments are considered secondary mitigations that are not viewed as effective in the long term because sediment has already been delivered to the channel (Robichaud et al., 2000). In addition, the application of some treatments has actually been shown to locally cause more damage that benefit. Research has shown that the most effective and cost-effective broad-based treatment for burned hillslope areas is mulching (Wagenbrenner et al., 2006), and that post-fire road treatments are infrequently employed by highly effective (Robichaud et al., 2000). BMPs for post-fire erosion and sediment control should be thoughtfully presented and individually supported by scientific and practical research. Otherwise, they cannot be considered BMPs.*
2) Native seed *- Although desirable, it is unlikely that "native or ecologically appropriate vegetation" will be available in quantities necessary for emergency response over large burned areas. In addition, seeding has not been found to be a universally effective post-fire erosion control treatment (MacDonald, 1989; Wagenbrenner et al., 2006)*
3) Weed-free mulch *- To avoid weed contamination when mulching it is possible that certified weed-free straw mulch or rice straw that contains no viable weed species will be available. These considerations should be clearly stated in the appropriate intent language and/or in the BMPs.*
4) Blocking roads and trails *- As opposed to road decommissioning, blocking roads and trails is not an appropriate rehabilitation treatment as it does not solve pending erosion or slope stability problems along the closed route.*
5) Temporary fire trail stream crossings *– All temporary stream crossings "constructed" in support of fire suppression activities should be properly decommissioned.*

***6) Post-fire road drainage and sediment treatments** - Finally, there are no suggested BMP measures related to upgrading surface drainage and stream crossing facilities on forest roads to accommodate the expected increase in runoff and fine sediment in the post-fire period. In many forested areas log truck traffic is also expected to increase as a result of salvage logging operations. This is a serious omission and should be corrected through the development and listing of BMPs for burn area road upgrading to reduce road system hydrologic connectivity, increase the peak flow capacity of stream crossing culverts to the post-fire 100-year design capacity), prevent culvert plugging, eliminate stream diversions and washouts, and eliminate (excavate) potential fillslope failures (e.g., see Robichaud et al., 2000).*

Table 279. Best Management Practices for Minerals Exploration and Development

***BMP**:* Use existing roads, skid trails, and stream crossings. (1175) *Taken literally, this "BMP" implies that there will be no new road or skid trail construction allowed on BLM lands to provide access or support for minerals exploration and development. If a BMP is not clearly and unambiguously stated then its potential impact and effectiveness cannot be evaluated. It is likely that this BMP is not accurately stating what is intended, and therefore is misleading and inaccurate.*

***BMP**:* Storm proof all natural surface roads and trails when an operation halts for the wet season. See Roads and Landings section for guidelines. (1175) *As identified for the Roads and Landings section of the DEIS, there is no definition for "storm-proofing" of roads and road systems. The BMPs for storm-proofing should be spelled out in detail in the DEIS. It is assumed that the language defining road stormproofing (upgrading) that is found in FEMAT (1993) is applicable, but this BMP is unclear without the supporting definition and description of techniques and standards. Without the clarification, "storm proofing" it cannot be evaluated or confirmed as an effective water quality BMP.*

***BMP**:* Prior to fall rains, reclaim all roads and trails constructed for exploratory purposes that are unnecessary for the mineral access. (1175) *There is no definition for "reclaiming" of roads and trails. If this means "decommission" then this word should be substituted and the appropriate BMPs should apply. If not, the BMPs for "road and trail reclaiming" in mining exploration areas should be spelled out in detail in the EIS. Without this definition and the associated standards, "road and trail reclaiming" cannot be evaluated as a BMP for the protection of water quality.*

***BMP**:* Retain an undisturbed riparian buffer strip between mineral operations and water bodies, floodplains, and wetlands. (1175) *This BMP is unsatisfactory. At a minimum, the width (or the factors that are evaluated to determine a variable width) and the relevant internal characteristics of a suitable riparian buffer must be described in the BMP.*

***BMP**:* On access roads to mineral sites where no future entry is planned, reclaim these access roads. This may include tilling, water barring, blocking, recontouring, fertilization, planting, mulching, and seeding. (1176) *As a restoration and sediment control practice "reclaim" has not been defined. Is this laundry list all the possible treatments for road reclamation? What about the critically important excavation and removal of stream crossing fills? How does this* *treatment differ from decommissioning treatments? If there is no difference road and trail decommissioning should be used as the appropriate BMP. It has been fully described by a suite of treatments in the existing DEIS BMP list.*

BMP*:* Reclaim depleted or closed mineral sites by stabilizing and contouring the mining area. Replace topsoil and mulch, seed, and plant. (1176) *Reclamation is a term typically employed to describe a suite of treatments designed to restore or reclaim a mined site or landscape after mining or exploration has been completed. It typically requires submittal of a reclamation plan and a suite of BMP treatments. Somewhere in the list of BMPs for reclamation there should be a complete description of the objectives of reclamation activities that are to be employed at mining and former mining sites on BLM lands as well as a technical description of the various BMPs (techniques) for performing reclamation activities. This BMP does not meet those needs and cannot be assumed to provide adequate protection to water quality.*

BMP*:* Locate exploratory drill sites next to or on existing roads. Install erosion control structures to limit sediment transport off-site. (1176) *This BMP literally indicates that no exploration drilling will be conducted on BLM lands except from or immediately adjacent existing roads. What is the maximum acceptable distance from roads that drilling will be allowed? If there is not a firm maximum distance, what are the criteria that will be used to make this determination? If a BMP is not clearly and unambiguously stated then its potential impact and effectiveness cannot be evaluated. It is possible that this BMP is not accurately stating what is intended, and therefore is misleading and inaccurate.*

BMP*:* When operating during the wet season, stabilize disturbed areas that will not be mined for at least 30 days. (1176) *There are no stated seasonal restrictions to equipment operations and land disturbing exploration and mining activities for BLM lands. This BMP does not restrict winter or wet weather operations. If winter operations are to be allowed, restricted or not permitted, then BMPs relevant to this work should be included in the EIS. Specific BMPs should be developed for any and all permitted activities that can be conducted during the winter period or during wet weather conditions.*

BMP*:* Stabilize roads, drill sites, and excavation areas to a free draining and non eroding condition from disturbed areas that are constructed or renovated for leasable mineral activities (e.g., roads, drill sites, and excavation areas). (1176) *The BMP should specifically define as one of the goals of "stabilization" to eliminate hydrologic connectivity between disturbed areas (including roads, drill sites and excavation areas) and adjacent streams. If there is exposed bare soil following these stabilization activities then there will be erosion. The requirement for a non-eroding condition that is stated in the BMP may be a difficult goal to achieve.*

Table 281. Best Management Practices for Restoration

General - In the National Fire Plan Project Design and Consultation Process Interagency [Web] Site the BLM has adopted "Road Restoration" as an Activity Component under the Roads and Road Maintenance Activity Type. It is further described by a variety of Work Elements that include road "stormproofing" as well as a number of road upgrading techniques that are designed to "improve road drainage capacity and add a margin of safety for increased flow" in the post-fire environment (http://www.blm.gov/or/fcp/files/Activity_Descriptions_2005.doc). These and similar techniques are similarly listed and summarized in FEMAT (1993) and are used to make the forest road system more resilient to failure during storm flows and to reduce surface runoff and fine sediment delivery to streams. However, the DEIS fails to mention or include these measures as restoration options for the 14,000 miles of existing roads in the BLM WOPR Plan area.

These BLM/interagency road restoration techniques for road upgrading and stormproofing are the same as those that are listed in FEMAT and that need be included as restoration BMPs in the WOPR DEIS. Without these BMPs, and the associated implementation plan for treating sediment sources from the existing road network, the DEIS falls considerably short of providing adequate water quality protection from the proposed activities in the Plan and its alternatives. Each of the three DEIS action alternatives propose to extensively and intensively use the existing forest road network in the conduct of increased forest harvesting. To protect these watersheds from the existing and increased risk of sedimentation, water quality degradation and aquatic impacts the DEIS for the Plan Revisions must include a plan for road upgrading and stormproofing, and the BMPs that are associated with these activities. It is inconsistent that the decommissioning of existing roads is included in the DEIS and Plan, but prioritized implementation plans and BMPs for road upgrading and stormproofing are omitted.

BMP*:* In well armored channels that are resistant to damage (e.g., bedrock, small boulder, or cobble dominated), consider conducting the majority of heavy-equipment work from within the channel to minimize damage to sensitive riparian areas. (1181) *This statement is a suggestion or description of intent, and not a BMP that is well defined and instructional.*

BMP*:* Confine heavy-equipment use in the streambed to the area necessary by working from the bank or a temporary structure for installation of structure to avoid flowing water. (1181) *This BMP is poorly worded and confusing. In addition, the BMP provides guidance that is conflicting with the previous (above) BMP statement. It suggests that most equipment work should be performed from the bank, and not from the streambed.*

BMP*:* Limit the amount of streambank excavation to the minimum necessary to ensure stability of enhancement structures. Provide isolation from flowing water during excavation. Place excavated material above the flood prone area and cover or place a berm to avoid its reentry into the stream during high flow events. (1182) *The BMP does not provide recurrence criteria for defining the extent of the "flood prone area." The flood prone area should be specifically defined as the area of inundation during the 100-year flood flow. Finally, the excavated spoil should be seeded and mulched rather than "covered." Covering is a temporary construction technique that must be followed by more permanent erosion control and revegetation treatments. Finally, the excavated material should be hauled off-site to a spoil disposal locatoin where eroded sediment cannot enter a stream channel. It should not be stored near a stream channel.*

BMP*:* Equipment will not be stored in stream channels when not in use. (1182) *Equipment should not be stored in channels, on stream crossings or anywhere where runoff from the storage site can flow into a stream (i.e., any hydrologically connected site).*

BMP*:* Refuel equipment, including chainsaws and other hand power tools, at least 100 feet from water bodies (or as far as possible from the water body where local site conditions do not allow a 150-foot setback) to prevent direct delivery of contaminants into a water body. (1182) *If stored on site for long or short periods, fuel trucks and portable fuel tanks shall be parked in an excavated containment basin with sufficient capacity to contain a spill of a full load of fuel.*

BMP*:* Rehabilitate and stabilize disturbed areas where soil will support seed growth by seeding and planting with native seed mixes or plants, or using erosion control matting. (1182) *No definition or objective has been stated for the term "rehabilitate." Does it mean restore to original conditions; or does it mean provide erosion control and site revegetation? BMPs should be very specific and unambiguous. Finally, disturbed area erosion control must use some type of mulching to provide coverage to bare soil areas for the first year. Seeding (by itself)* <u>*or*</u> *the use of matting (by itself) does not provide sufficient protection to the site.*

BMP*:* When replacing culverts, install grade control structures (e.g., boulder vortex weirs or boulder step weirs). (1182) *This BMP is poorly stated and the purpose of the treatment is unclear (or unstated). The BMP implies that one must always install grade control structures when replacing culverts. This is not necessary and would be counter-productive in many circumstances. The causal mechanism for this BMP is listed as: "Excessive turbidity and sedimentation to downstream areas due to erosion of upstream sand/gravel/cobble deposits." This implies the release of channel-stored sediment that has accumulated upstream from the culvert that is being replaced. A more appropriate BMP would be for the excavation and removal of all channel-stored sediment located upstream from culverts that are being replaced or upgraded, rather than trying to stabilize the sediment stored in the channel using grade control structures.*

The DEIS BMP calls for installing boulder weirs when replacing all culverts (no limitations or exceptions are provided). There is no guidance on where the weir should be constructed, or the specifications that should be employed to make them functional and resistant to failure during design storm flows. Design and site location criteria are needed. Most culverted stream crossings do not involve grade control issues that would require construction of weirs. Finally, it is unclear why this BMP was not included in the roads and landings BMP section if every stream crossing culvert replacement would require weir construction.

BMP*:* Rehabilitate headcuts and gullies. (1183) *This is poorly stated and vague "BMP." What does the term "rehabilitate" mean? Most often, the most appropriate BMP treatment for headcuts and gullies is to remove the flow that has been delivered to the headcut or gully and is the cause for its formation and continued growth and activity. Only after all other methods have been thoroughly evaluated would the use of structural or biotechnical gully control measures be appropriate. As written, this is not a satisfactory BMP. It does not provide objectives, design guidance, specifications or installation techniques.*

BMP*:* <u>Appendix L – Grazing</u> (1261) For reservoir construction in a grazing area, the DEIS states "The spillway would be designed to minimize the risk of the dam being overtopped during the design life of the structure" and "Fill material, if needed, would come from the impoundment area and/or a borrow area for dams." (1265) *The listed reservoir "BMPs" are non-specific and too generalized. Reservoir construction should have a suite of specific and detailed design,* *construction and erosion control BMPs developed and listed in the EIS. The two elements that are listed above (spillway construction and borrow site development) are important design elements associated with reservoir construction. They are also design elements that can lead to adverse downstream impacts to the aquatic system if they are not designed and implemented correctly. A few of the appropriate standards include: 1) Biologists should review the potential downstream impacts of any proposed water retention project on all species that use the stream network, not just on threatened, endangered or special status species. 2) Constructed reservoirs should be designed by a licensed engineer, and include analyses for appropriate materials and compaction standards. 3) Reservoirs and dams should be fitted with high flow culverted outfalls (to keep reservoir water levels to safe levels) in addition to an emergency overflow spillway. 4) The emergency spillway should be engineered and designed to accommodate the 100 year flood overflow. 5) The dam faces and sideslopes should be protected with seed, mulch and other erosion control measures so that winter rainfall minimizes turbid releases into the stream system. 6) Borrow sites for reservoirs should be evaluated by a geologist or engineering geologist for suitable fill material characteristics. 7) Borrow sites should be fully reclaimed and stabilized prior to the first winter period so that eroded sediment is not discharged to the reservoir or a stream channel.*

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EDUCATION

Ph.D. Earth Resources: 1986
Colorado State University, Fort Collins, Colorado
Emphasis in process geomorphology, erosion and sedimentation processes, hydrology, watershed assessment & hillslope evolution

B.S. Geological Sciences: 1973
University of Washington, Seattle, Washington

ACADEMIC AND ADVISORY APPOINTMENTS

1999 - present 1988 - 1995	Adjunct Professor, Department of Geology Humboldt State University, Arcata, California
1994 - 2000	Appointed, Board of Directors, Humboldt County Resource Conservation District (RCD), Eureka, Ca.
1996 - 1997	Appointed Member, Scientific Advisory Panel, California Coastal Salmon Initiative, The Resources Agency
1988 - 1989	Appointed Member, California State Board of Forestry Task Force investigating forest road construction and landsliding.
1979 - 1985	Appointed Member, Coast Forest District Technical Advisory Committee to the Ca. State Bd. of Forestry.

PROFESSIONAL LICENSES

Washington Registered Geologist # 2014
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SUMMARY OF EXPERIENCE

Dr. Weaver has over 27 years of professional experience in the fields of process geomorphology, surface water hydrology, watershed management and engineering geology. Since forming Pacific Watershed Associates, his work has focused on forest geomorphology, and the hydrologic and cumulative effects of land management on forested watersheds and wetlands ecosystems. Recently this work has concentrated on sediment source investigations and evaluating, planning and designing watershed rehabilitation and sediment control activities in steepland drainage basins for the purpose water quality protection, erosion control and fisheries restoration. As the principal Engineering Geologist at Redwood National Park for 13 years, Dr. Weaver was instrumental in the design, initiation, and monitoring the internationally recognized watershed rehabilitation and erosion control program at the park. His Doctorate in earth sciences and hydrology focused on fluvial erosion and sedimentation processes.

Dr. Weaver has served on a number of task forces and technical committees appointed by the California State Board of Forestry to evaluate and recommend changes to the California Forest Practice Regulations covering timber harvest and road building on private forest lands. From 1994-2000 he served on the Board of Directors for the Humboldt County Resource Conservation District (a soil and resource conservation organization) and is Board President of Friends of the Dunes, a local coastal conservation group. Dr. Weaver is considered a leading national expert in the field of road-related erosion and sediment control for forest and ranch road systems.

Dr. Weaver is co-author of a book published by McGraw-Hill on experimental geomorphology and has authored a number of publications on geomorphology, watershed assessment techniques, and steep-land erosion prevention practices. His publications include a U.S. Geological Survey Professional Paper on forest land gully erosion, the *"Handbook for Forest and Ranch Roads,"* a practical field guide commissioned by the California Dept of Forestry and Fire Protection and the Natural Resources Conservation Service and "*Upslope Assessment and Restoration Practices*" (Chapter 10 of the CDFG Habitat Restoration Manual). Three recent publications, "*Storm-proofing Forest Roads*," "*Sediment Treatments and Road Restoration"* and *"Road Upgrading, Decommissioning and Maintenance - Estimating Costs on Small and Large Scales*" detail his recent work on developing technical procedures for water quality and fisheries protection that have been developed for both road upgrading, road decommissioning and erosion control in steep mountainous watersheds of the Pacific Northwest.

Finally, Dr. Weaver is also a leading expert and technical trainer in the fields of erosion and sedimentation, erosion control, water quality protection and the management of sediment sources along public and private roads. He conducts numerous technical training sessions and workshops on erosion processes and non-point sediment control across the state each year. Dr. Weaver is recognized for his ability to prepare and present technical, science-based workshops on topics in a manner that is easily understood by both technical and non-technical audiences, including landowners, equipment operators, land managers, regulatory personnel, environmentalists, and other scientists and consultants.

PROFESSIONAL EXPERIENCE

1989 – present	PRINCIPAL GEOMORPHOLOGIST/HYDROLOGIST Pacific Watershed Associates Arcata, California
1988 - 1995 1999 – present	ADJUNCT PROFESSOR Geology Department, Humboldt State University Arcata, California
1976 - 1989	ENGINEERING GEOLOGIST National Park Service, Redwood National Park Arcata, California
1973 - 1976	RESEARCH ASSISTANT Department of Earth Resources Colorado State University, Fort Collins, Colorado

PUBLICATIONS

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EDUCATION

B.S. Geological Sciences: 1978
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Emphasis in applied geology, geomorphology, surface water hydrology, watershed management, engineering geology and Quaternary geology.

ADVISORY APPOINTMENTS

1986 - present Advisory Board, Arcata Community Forest, Arcata, CA

PROFESSIONAL LICENSES

Certified Soil Erosion and Sediment Control Specialist #494

SUMMARY OF EXPERIENCE

Mr. Hagans has extensive experience in conducting large scale, basin-wide erosion inventories and assessments, as well as implementing watershed rehabilitation and restoration projects in Northern California and elsewhere. He has 12 years professional experience as a National Park Service geologist at Redwood National Park, California. During this time he worked on the development and implementation of the park's internationally recognized watershed rehabilitation program, on geomorphic research projects and on technical review of private land timber harvesting and road building proposals in the 280 mi^2 Redwood Creek watershed. He specifically investigated the role of forest land use and road construction on mass wasting and erosion. He is skilled on the development of sediment budgets for coastal forested watersheds.

Since joining Pacific Watershed Associates in 1990, Mr. Hagans has managed and conducted a variety of projects related to wildland hydrology and erosion processes, including sediment source assessments of over 2000 mi^2 of managed forest land and erosion inventories and sediment reduction plans for literally thousands of miles of wildland forest roads, ranch roads, rural subdivision roads, vineyard roads, parkland roads, and county maintained public roads throughout northern and central California. He has conducted a number of sediment source investigations for the EPA (in response to TMDL requirements), private landowners, the USFS (watershed analyses and Ecological Unit Inventories), BLM (watershed sediment reduction planning) and the National Park Service (river management studies). Mr. Hagans has also completed dozens of studies and erosion prevention plans for northern California Indian Tribes, State Agencies, rural subdivisions and industrial and non-industrial forest-and ranch landowners. Mr. Hagans is a recognized expert in the identification and treatment of watershed erosion and sedimentation problems, especially those related to land management and road construction. He has developed and implemented numerous plans for both road upgrading and road decommissioning projects throughout Northern California.

Mr. Hagans is also a leading expert and technical trainer in the fields of erosion and sedimentation, erosion control, water quality protection and the management of sediment sources along public and private roads. He conducts numerous technical training sessions and workshops on erosion processes and non-point sediment control across the state each year. Mr. Hagans is recognized for his ability to prepare and present technical, science-based workshops on topics in a manner that is easily understood by both technical and non-technical audiences, including landowners, equipment operators, land managers, regulatory personnel, environmentalists, and other scientists and consultants.

Mr. Hagans has conducted research and published articles on the magnitude and causes of forest land erosion, and especially on the effects of land use on erosion rates and processes, and cumulative watershed effects. He is co-author of two USGS Professional Papers, the *"Handbook for Forest and Ranch Roads"* (commissioned by the California Department of Forestry and the U.S. Soil Conservation Service), Chapter 10 of the CDFG Fish Habitat Restoration Manual f("Upslope assessment and restoration practices") and numerous other reports and papers. Mr. Hagans is currently serving as an appointed member of the Arcata Community Forest Advisory Committee for the city of Arcata, California.

PROFESSIONAL EXPERIENCE

1990 - present	PRINCIPAL EARTH SCIENTIST Pacific Watershed Associates, Arcata, California
1978 - 1990:	GEOLOGIST, Redwood National Park Arcata, California
1977-1978:	MINING GEOLOGIST, Western Nuclear Corp. Jeffer City, Wyoming
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PROFESSIONAL ASSOCIATIONS

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SELECTED PUBLICATIONS

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